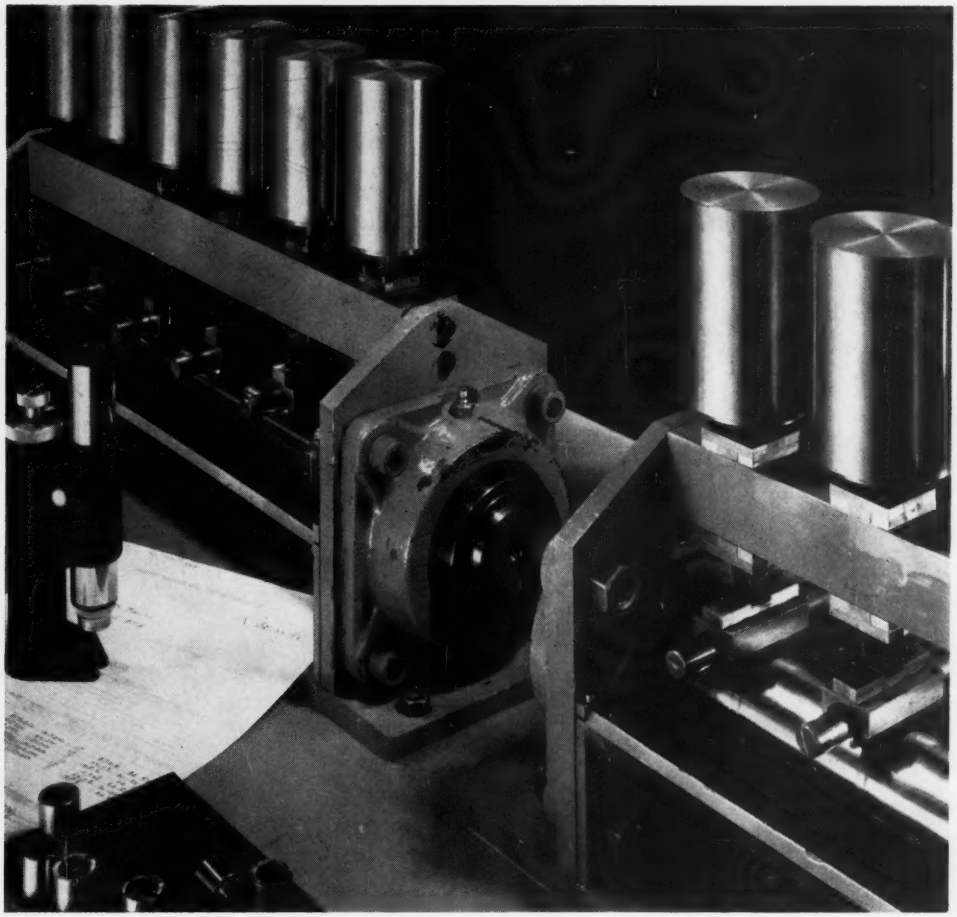
LUBRICATION ENGINEERING

RESEARCH APPLICATION EDUCATION MAINTENANCE



Wear Testing

JOURNAL OF THE AMERICAN SOCIETY OF LUBRICATION ENGINEERS

Farval lubrication helps side milling machine work at faster speeds

FARVAL—
Studies in Centralized Lubrication
No. 213

● Designed and built by Portland Machine Tool Works, this machine is used for side milling laminated steel plates in a western Pennsylvania steel plant. Employing a climb cut, both milling heads generate extreme downward pressures on the table ways. To protect against these extreme pressures on the ways, a Farval lubrication system was installed.

Result—unusually high speeds in milling are possible and usual, and not an hour of production time has been lost due to faulty lubrication. Periodic operation of the Farval hand pump keeps the ways working perfectly.

Free Lubrication Survey—Why not find out where Farval can save you time and money? One of our lubrication engineers will be glad to inspect your plant equipment. He will present a written analysis, without obligation, of what Farval can do for you. And for the complete Farval story, write for Bulletin 26-S, The Farval Corporation, 3267 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing.
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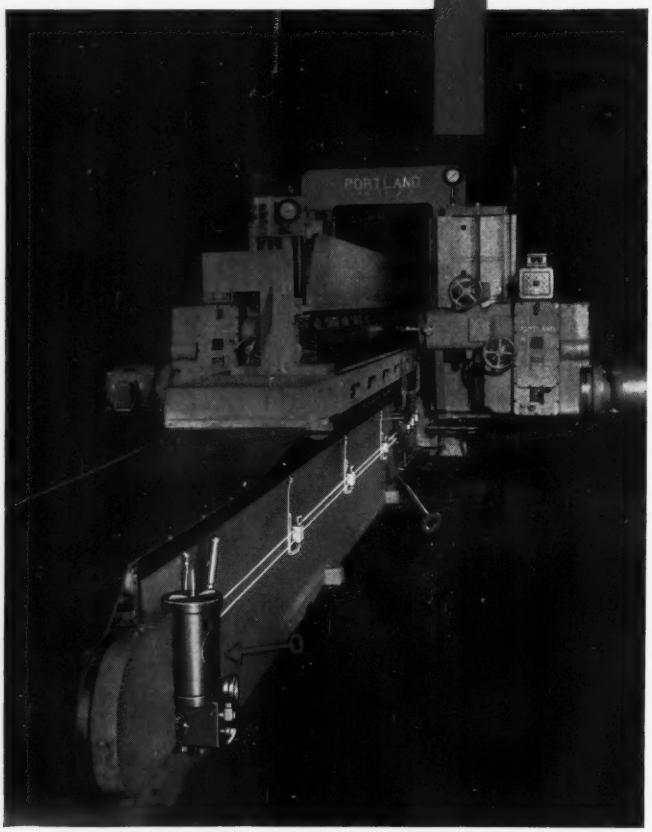
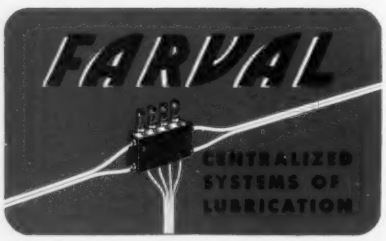


KEYS TO ADEQUATE LUBRICATION—**The familiar Dualine Valve manifolds, dual lubricant lines and central pumping station are the sign of Farval—the sign that a machine is being properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.**

Above is the Portland conversion side milling machine on which ways are now protected by a Farval system.



LUBRICATION ENGINEERING

RESEARCH APPLICATION EDUCATION MAINTENANCE

Volume 14, No. 2

February, 1958

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COVER STORY

There are two approaches to the problems of wear: reduction of friction as by lubrication and improvement in the wear characteristics of materials. Improvement in wear resistance of steel under certain conditions by the addition of copper has been cited in the literature, and more recently has been the subject of special study by La Salle Steel Co., Chicago, Ill.

By modifying a special testing machine developed by the Favelle-Le Valley Corp. for the testing of E-P lubricants, wear tests have been made to evaluate antiseize properties for various steel bar formulations. A pin of the material to be tested is placed between two V blocks, and the pin is rotated at a constant speed while submerged in a special oil used as a coolant. Pressure of the V blocks on the pin is varied to the desired pressure, or until seizure occurs. By examination of the pin's surface, a rating system was devised for the material under test.

Testing of this type has led to the development of a product which exhibits superior resistance to seizure compared with a conventional carbon alloy steel quenched and tempered to a comparable hardness level.

Additional activity in wear testing led to the development of the Constant Pressure Wear Tester shown this month on our cover. Several specimens can be tested simultaneously. The specimens are attached to a rod, free to move vertically. A specified weight presses each specimen against a chromium plated bar which is rotated. The bar is suspended in an oil bath to provide lubrication. Usually 1 million cycles are run before removing the rods for inspection and optical measurement of wear. The smaller the wear area the better the specimen's resistance to wear.

Tests of this type play an increasing role in our continual search for improved methods and materials *(Photograph courtesy of La Steel Co., Chicago, Ill.)*

ASLE Meeting Program

April 22, 23 and 24, 1958

Hotel Cleveland, Cleveland, Ohio

A total of 18 sessions are scheduled for the three-day period with an average of four papers being presented at each session. Investigations of all phases of the lubrication industry will be presented according to the following schedule:

Tuesday 10 to 12 noon—April 22

Session 1A—Properties and Performances of Seals
V. E. Vorhees, Session Organizing Chairman
Session 1B—Oil Conditioning and Reconditioning
W. H. Craig, Session Organizing Chairman
Session 1C
Harold Chalk, Session Organizing Chairman

Tuesday 2 to 5 P.M.—April 22

Session 2A—Cleveland Industry
S. B. Twiss, Session Organizing Chairman
Session 2B—Railroad Lubrication
L. E. Hoyer, Session Organizing Chairman
Session 2C—Test Methods and Equipment
Bernard Rubin, Session Organizing Chairman

Wednesday 9 to 12 noon—April 23

Session 3A—Research Techniques for Studying Wear Surfaces
I-Ming Feng, Session Organizing Chairman
Session 3B—Metalworking Techniques
E. W. Hitchcock, Session Organizing Chairman
Session 3C—Centralized Lubrication
D. G. Reed, Session Organizing Chairman

Wednesday 2 to 5 P.M.—April 23

Session 4A—Thermal Effects in Hydrodynamic Lubrication
Beno Sternlicht, Session Organizing Chairman
Session 4B
E. W. Hitchcock, Session Organizing Chairman
Session 4C—Panel: "The Four R's of Lubrication"
R. C. Garretson, Session Organizing Chairman

Thursday 9 to 12 noon—April 24

Session 5A—Roller Contact Bearings
H. E. Kaye, Session Organizing Chairman
Session 5B—Environmental Factors Affecting Lubricant Performance
J. F. Cook, Session Organizing Chairman
Session 5C—Centralized Lubrication
John W. Fauver, Session Organizing Chairman

Thursday 2 to 5 P.M.—April 24

Session 6A—Sliding Bearings
C. M. Allen, Session Organizing Chairman
Session 6B—Gear Lubrication
C. F. Huber, Session Organizing Chairman
Session 6C—Performance Characteristics of Hydraulic Fluids
L. B. Sargent, Jr., Session Organizing Chairman

Complete program with titles of papers will appear in the March 1958 issue of LUBRICATION ENGINEERING.

Uses one soluble cutting oil for class 4 steel, all other jobs!

Precision Parts made from hard alloy steels and other metals have brought an excellent reputation to Industrial Machine & Engineering Company. All are cut with Cities Service Chillo T Oil.

Plant Manager Steven Peti pioneered 10 years ago in use of soluble cutting oil for tough steel cutting jobs. Chose Cities Service Chillo T Oil after much experimentation with water solubles.

Whether it's brass, bronze, steel, or aluminum–and whatever its degree of hardness – Industrial Machine & Engineering Company cuts it with ease using Cities Service Chillo T Cutting Oil.

"In fact," says Plant Manager Steven Peti, "we've been doing it successfully for the past ten years. Of course, it wasn't easy to find the correct oil for all these jobs – and many people said a soluble oil couldn't possibly handle them all. But after considerable experimenting, we found that Cities Service Chillo T Cutting Oil not only could handle them, but save money in the process.

"Today, we have a shop completely free of smoke (some change from the old days when we used sulphur chlorinated oils) and never have to change oils for any job.

"In addition, we have found the oil has excellent extreme pressure qualities, an effective anti-rust inhibitor, and is a fine lubricant. Partly because of Chillo T, we've gained an excellent reputation for cutting precision parts from 347, 321, and 410 stainless steel, as well as 8740, 4130, and 4340 alloy steel. Naturally, we're mighty happy to do business with Cities Service."

Again and again, where there's a cutting problem, the answer lies in one of the Cities Service Chillo Cutting Oils. Find out which of these oils best suits your needs. Call in a Cities Service Lubrication Engineer, or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

Survey Rates Thread Waste Very High in Absorbency

Cotton thread waste absorbs up to three or four times its own weight of oil, a fact that makes it several times as effective as cloth as a wiping medium, according to comparative tests carried out by the Robert W. Hunt Company for the Institute of Thread Machiners, Inc.

All samples were conditioned at 70°F and 65 percent relative humidity for 24 hours before testing. In one of the tests, No. 1 cotton thread waste (colored) absorbed oil to the extent of more than 400 percent of its conditioned weight. By comparison, specimens of commonly-used wiping clothes absorbed less than 140 percent of their conditioned weight in oil.

Tests were carried out under controlled conditions using wiping pads of equal weight of cloth and waste. SAE 10-20 oil was used. The oil, poured into a shallow pan, was wiped up by cloth or waste until all further absorbency had been lost. Specimens were drip-dried for 18 hours and then weighed.

W. R. Compton, Jr., executive director of the Institute of Thread Machiners, says that the results of the laboratory tests confirm the greater absorption capacity of wiping waste compared with wiping cloths long recognized by maintenance personnel. In waste, he continued, the entire circumferential area of each of the hundreds of threads in a handful is exposed for maximum absorption. In wiping cloths, on the other hand, only two two sides of each thread are exposed.

Reynolds Sets Up Division to Market Rigid Containers

A Rigid Container Division has been established by Reynolds Metals Company to plan marketing of aluminum containers such as oil cans and to set up a research program to determine their potential.

The division was created because of the growing importance of the can industry to the aluminum industry. American Can Company and Crown Cork and Seal Company are now in production on a contract recently negotiated by Reynolds and Esso Standard Oil Company calling for 35 million to 60 million quart-sized cylindrical aluminum cans for motor oil. Reynolds is supplying the aluminum.

J. Louis Reynolds, executive vice-president of the corporation, said that the new division will be headed by L. R. Payton who will be headquartered at the firm's corporate headquarters in Richmond, Va.

Slate ASME Confab On Viscosity Role

"The Role of Viscosity in Lubrication" will be the subject of a two-day symposium sponsored by the Lubrication Division of the American Society of Mechanical Engineers to be held March 10 and 11 at 150 East 42nd Street, New York City.

Preliminary plans for the symposium include discussions on viscosity and how it varies with temperature, pressure and rate of shear; the sensitivity of lubricated parts to changes in viscosity, and the criteria the designer uses when selecting the viscosity of the lubricant for which he designs a bearing or gear. One session will be devoted to each of these themes and the final session will be a summary and general discussion.

The symposium is expected to bring out practical information on the extent to which viscosity can be changed and on the extent to which load, speed or temperatures can be varied from the design condition without creating lubrication difficulties.

Grease Survey Is Planned

The oil industry should have an accurate picture of the trend in lubricating greases after mid-year, 1958, according to R. Cubicciotti, president of the National Lubricating Grease Institute. By that time, data from members of the Institute will have been tabulated and results from the first NLGI lubricating grease production survey will be known.

Figures will be taken from production of the year 1957 and Cubicciotti stressed that only production figures will be asked of manufacturing members. This qualification should eliminate the duplication that sale and resale might bring if marketing statistics were used, he added.

The great majority of the Institute's domestic manufacturing members have already agreed to participate and since NLGI represents what is estimated to be over 95 percent of the lubricating grease industry in this country, an exceptionally accurate evaluation is expected.

Courses Slated For Safety Men

The National Safety Council has announced two "Safety Management Techniques" training courses for safety men. The one-week courses are scheduled for February 24-28 and May 19-23.

"Safety Management Techniques," a course for qualified safety men, is calculated to improve skills in communication, human relations and safety program planning. The course will cover psychology, photography, public speaking, professional writing and conference leading for the safety man.

In addition, a safety program clinic will be included.

The course, which aims to help safety men by giving them a broader outlook and greater skill in management techniques, is open to those whose experience and knowledge make it unnecessary for them first to take another Council course, "Fundamentals of Industrial Safety." Graduates of that course are also eligible.

Product Literature

SILICONE COMPOUNDS' USES

An eight-page data sheet describing the properties and uses of Union Carbide silicone compounds of the 520 series is now available. These compounds, designated "Union Carbide" X-520, X-521L-522, X-525, X-526 or X-527 silicone compound, are organo-silicone polymers with unusual lubricating and solubility properties. L-522 has established itself as a release agent for the tire industry. Properties of the other compounds suggest their usefulness as special machine or metal lubricants, release agents for plastics and emulsifying agents or emulsion breakers. Copies of Form SF-1010A describing the silicone compounds may be obtained by writing to Silicones Division, Union Carbide Corp., 30 E. 42nd St., New York 17, N. Y.

ISOTOPE PRICE LIST

BIO-RAD Laboratories has produced a new price list "C" covering radioactive isotopes and isotope-labeled compounds. This publication adds to previous issues an expanded list of carbon-14 compounds and new sections describing heavy water, deuterium- and titium-labeled compounds, and new nitrogen-15 compounds of high isotopic concentration. Containing a convenient alphabetical list and cross reference, the book includes the following carbon-14 labeled compounds: acids and derivatives; amino acids; purines, pyrimidines, and related compounds; aldehydes and ketones; hydrocarbons; alcohols and derivatives; plant-growth regulators; sugars; benzene-ring-labeled compounds; steroids; and others. It includes under stable isotopes, heavy water and deuterium gas, as well as deuterium labeled compounds. Price list "C" is available from BIO-RAD Laboratories, 802 Delaware St., Berkeley, Calif. *(more on p. 72)*

ACHESON

dispersions digest

Reporting uses for

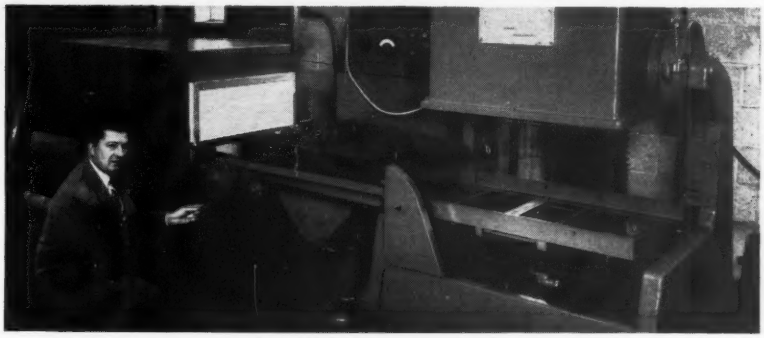
dag® BRAND DISPERSIONS

COLLOIDAL GRAPHITE, MOLYBDENUM DISULFIDE, VERMICULITE, AND OTHER SOLIDS

'DAG' DISPERSIONS SHRUG OFF HEAT, KEEP PRODUCTION ROLLING

With temperatures up to 1600° F. and above being generated in various types of industrial ovens, furnaces and kilns, lubricants for bearings and other moving parts must be very carefully selected. To satisfactorily resist oxidation, heavy pressures, and reduce wear on bearing surfaces, 'dag' colloidal graphite has been accepted as having all of the properties necessary to maintenance-free performance.

Dependable bearing lubrication of pattern carriages on shell molding machines is a "must" at Production Pattern and Foundry Co., Chicopee, Massachusetts. With five shell molding machines operating three shifts a day to supply their casting floor, uninterrupted service has to be maintained. These carriages shuttle back and forth between curing ovens and investing box . . . from 900° F. to 400° F. The three friction points that require special lubrication in this operation are: axle bearings for the 4-wheel pattern carriages; the pivots for the two-hitch mounts at each end of the carriages; and the link pins of the roller chains which propel the carriages back and forth across the bed of the machine. 'Oildag' — colloidal graphite in a petroleum oil carrier — is applied once a day to the bearings and pivot points, every 12 hours to the link pins. The result: where conventional oils and greases before had decomposed leaving a tarry residue or a non-lubricating soap, 'Oildag' retained its lubricating properties under both heat and load pressures. 'Oildag' is economical and heat resistant . . . necessary characteristics to its use in this application. With regular use, lubricants containing 'dag' colloidal graphite form a low-friction graphoid film that adheres tenaciously to the bearing surface, effectively resisting rupture, oxidation, and wear. Proof of this effectiveness? Life of these bearing segments now runs about 400 hours . . . *eight times longer than before!* According to Earl W. Jahn, President of Production Pattern and Foundry, "Until we discovered the dependable high-temperature lubrication performance provided by the Oildag mixture, we just weren't in business."



24 hours a day, at temperatures up to 900° F., Oildag provides maintenance-free lubrication of shell mold pattern carriages at Production Pattern & Foundry.

Studebaker-Packard Corporation's Foundry Department finds 'dag' No. 2404 saves on material, labor, and conveyor wear.

'dag' colloidal graphite solves conveyor lubrication for Studebaker-Packard. Their Foundry Department needed the answer to more efficient conveyor lubrication in baking ovens where operating temperatures ranged from 250° to 450° F. Heat caused gumming and partial decomposition of both the heavy greases and conventional non-graphited oils used. The residual deposit left resulted in "frozen" bearings requiring excessive down-time, as well as parts replacement.

By applying a dilution of 'dag' No. 2404—colloidal graphite in a mineral spirits carrier—on bearings, bushings, races and other critical parts, Studebaker-Packard found the ready-made solution. Application of these microscopically-fine particles was easily made through their automatic spray system. The excellent wetting action of the carrier deposited an unbroken film on all critical surfaces. The resulting dry film prevented accumulation of abrasive dust or sticky residue, allowing worthwhile savings in lubricant, labor, and conveyor wear. For further information on high temperature applications write for Bulletins 423 and 424. Address Dept. LE-28.

Call in your Acheson Service Engineer today.

ACHESON *Colloids Company*

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Lube Lines

by A. F. Brewer*

BREAK-IN

Break-in as customarily understood in connection with the operation of machinery relates to preparation for dependable service. Practically speaking break-in is a process of wearing-in whereby the component parts of a machine are operated under reduced speed and often reduced load in order to smooth out the "rough" spots in the mechanisms so that they will subsequently function in unison with the maximum of efficiency and minimum of power consumption.

Lubrication is the basic essential to break-in. It is realized when we follow the owner's manual instructions while putting the first thousand miles on our new car. Management realizes it by relying upon the lubrication engineer and plant people to run the new turbine, compressor, Diesel, steel rolling or paper machine, etc. under most carefully controlled conditions.

Why It Is Necessary

New machinery elements are often assembled somewhat more tightly than they are expected to be after break-in. Wear-in during the break-in period is important because it loosens up these mechanical assemblies (so to speak) and enables them to run freely in either rotating or reciprocating motion with respect to the component parts.

The Relation to Effective Lubrication

Bearing metals and the type and arrangement of gear trains have an important relationship to break-in. What this actually means is that the metallurgy of the parts must be related to the chemistry of the lubricants. This is particularly important in engine construction where bearing alloys of copper-lead can be subject to corrosion unless the lubricating oil is adequately fortified with special inhibiting additives.

Other types of machines present equally as important requirements which relate so often to resistance to oxidation and ability to carry the prevailing loads. When the lubricant is able to provide the greatest protection of the parts when they are set up to unusually close fit or tolerance the subsequent functioning of both can be anticipated more positively. The lubricant through its oiliness and film strength, in addition to the actual job of lubrication and prevention of wear, must:

1. Retain its original physical and chemical characteristics as closely as possible.
2. Serve as a rust and corrosion preventive.
3. Maintain the desired seal between piston rings and cylinders in engines, pumps and compressors; likewise in bearing elements and other parts to prevent leakage, or entry of abrasive foreign matter.
4. Retain its pumpability characteristic over the expected temperature range.
5. Resist formation of emulsions and sludge.
6. With oils, permit insoluble contaminants such as metallic (wear) particles or dirt to settle out rapidly.

When the lubricant is physically and chemically capable of providing most positive protection of the machine parts, there is greatest assurance that these will be properly broken in. Subsequent operation more dependably will pay off in more continuous production whether of power or usable goods.

TABLE OF BREAK-IN PROCEDURE

1. Check manufacturer's recommendations as to speed range.
2. Check type of bearings.
3. Check type of gears.
4. Check manufacturer's suggestion as to oil viscosity or grease consistency.
5. Check to be sure that machine is clean.
6. Study details of the lubricating system to be sure that all operating parts will be thoroughly lubricated.
7. Note arrangement of lubricant piping, fittings and control valves.
8. Note type of oil reconditioning system (where installed) and provisions for oil temperature control.
9. Install thermometers or other suitable means to check temperature of the most important bearings.
10. Record temperatures and note any tendency towards overheating.
11. Check for cause of overheating.
12. During break-in period, stop the machine at regular intervals and check for accumulation of abrasive foreign matter.
13. Check seals and packing glands for leakage.
14. Toward end of break-in period load and speed can be gradually increased until the unit is able to function at intended load. When this is practicable the unit can be presumed to be properly broken in.

*Consultant, and author of *Basic Lubrication Practive.*

MEMO:

TO:
UNION CARBIDE CHEMICALS COMPANY
30 East 42nd Street
New York 17, New York

Gentlemen:

I have heard about the many and varied applications of Ucon fluids and lubricants. Please tell me how I can use them as:

☐.....Hydraulic fluids
☐.....Fire-resistant hydraulic fluids
☐.....Gear lubricants
☐.....High-temperature lubricants
☐.....Low-temperature lubricants
☐.....Rubber lubricants
☐.....Packing lubricants
☐.....Compressor and Pump lubricants
☐.....Lift-truck lubricants
☐.....Metal-working fluids
☐.....Heat-transfer fluids
☐.....Grease components
☐.....Textile lubricants
☐.....Defoamers and De-emulsifiers
☐.....Cosmetic components
☐.....Ink and dye diluents
☐.....Leather softeners
☐.....Solvents and Plasticizers
☐.....Chemical intermediates

NAME_____

ADDRESS_____

Specific requirements for the job I have in mind are:

UNION CARBIDE CHEMICALS COMPANY

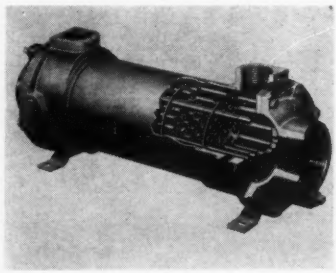
DIVISION OF UNION CARBIDE CORPORATION

"Ucon" is a registered trade-mark of Union Carbide Corporation

New Products

REDESIGNED BCF EXCHANGERS

An expanded line of Type BCF Exchangers with improved performance, new design features and new materials is now



available at lower prices. The 1958 BCF is offered in 46 sizes, one, two and four pass designs, and 1.2 to 124 square feet of heat transfer surface. Pre-engineered and carried in stock, the new line embodies numerous improvements such as (1) new baffle structure with flanged lip at each tube hole and around outer edge, giving tighter tube fit and improved thermal characteristics (2) stamped steel feet movable in three positions around hubs for easy, more adaptable mounting (3) hubs relieved under connections for unrestricted flow, and (4) corrosion-resistant copper alloy core assembly and rugged cast-iron bonnets. Complete information can be obtained by requesting Ross Bulletin 1.1K6 from Ross Heat Exchanger Div. of American-Standard, Buffalo 5, N. Y.

SELF-LUBRICATING BEARINGS

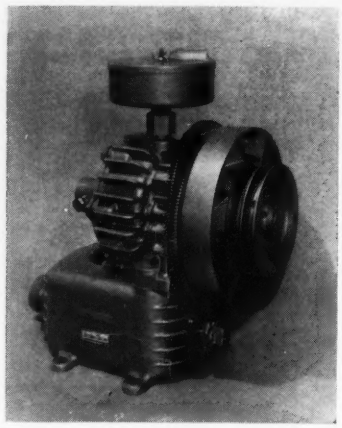
A new line of hanger bearing assemblies for industrial conveyor rolls is being manufactured. Each assembly has a Graphalloy bushing, a composition which is actually in itself a dry lubricant able to retain its properties over a wide temperature range (—450°F to 750°F). Graphalloy assemblies are used extensively in high temperature equipment such as dryer and oven conveyors — where oil and grease would volatilize and cause product contamination or fire — and are particularly suitable for roller dryers. The bushings do not attract dirt or lint and cannot contaminate food or pharmaceuticals. They can be used in water, gasoline, acids, dyes and other fluids without swelling or changing dimension. Detailed information on the full line may be obtained by writing Graphite Metallizing Corp., Yonkers, N. Y.

NEW IMMERSIBLE MOTOR FOR SUBMERGED OPERATION

An immersible motor for submerged operation has been designed for close-coupling to agitators or pumps in sewage sumps, chemicals, water and abrasive industrial oils. In pump applications, this flange-mounted motor eliminates many connecting components such as intermediate bearings, couplings, shafting and special bases since the motor shaft is attached directly to the impeller. Motor and pump can be raised and lowered into position together by means of the motor's lifting lugs. Features include leak-tight construction, neoprene breathers, waterproof cable connection, compact design and corrosion-resistant parts. The motor is engineered for submerged pumping service, mixers, agitators and special applications and is available in ratings of ¾ to 40 hp, both single and polyphase. For complete information, request Bulletin No. 2300 from the Louis Allis Co., Dept. P, 427 E. Stewart St., Milwaukee 1, Wisc.

SINGLE STAGE COMPRESSOR

Described as the first single stage "sliding vane" rotary compressor offered in a small, general utility size, a new unit manu-



factured by the Kellogg Division of American Brake Shore Company weighs only 44 lb. but reportedly has a rated output equal to that of a piston unit weighing more than twice as much. The new compressor is manufactured in 1½ and 2 hp ranges and is being recommended for general utility purposes including applications in garages, service stations and machine shops. The unique sliding vane principle of compression uses a rotor turning within an off-center housing. Compression up to 200 lb. psi is attained. Features of the unit include a self-contained circulating oil system which both seals and lubricates. A filter system removes oil from compressed air and returns it to a sump; a cut-off switch prevents operation if oil level drops too low.

IN JET ENGINE BEARINGS

Tomorrow's Horizons are here today

and ROLLWAY is ready

Today's supersonic speeds are pushing performance limits for jet engine main shaft bearings constantly upward. As new speed and thermal barriers confront the engineer, bearing precision, dimensional stability and surface finishes become increasingly critical.

Rollway experts are prepared for these challenges.

Right now, at Rollway, new high-temperature steels are being studied for use in ever-higher speed and thermal ranges. Experienced engineers and designers unite their skill with Rollway's quality control personnel to maintain exacting standards — from laboratory experimentation to rigid pre-installation testing.

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Personals

George W. Hedden, Jr., has been appointed assistant manager of manufacturing for the Organic Chemicals Division of American Cyanamid Company. He will be responsible for the operations of Cyanamid plants at Charlotte, N. C., Marietta, Ohio, Willow Island, W. Va. and Damascus, Va., with headquarters at Bound Brook, N. J.

The Garlock Packing Company of Palmyra, N. Y. has announced the appointment of E. W. Quiggle as product manager of the molded-extruded rubber line. William Hartranft has been named product manager of the company's gasketing line.

E. W. Quiggle

T. E. Veltfort, managing director of the Copper and Brass Research Association, has been elected chairman of the standards council of the American Standards Association. Harold Massey, managing director of the Gas Appliance Manufacturers Association was elected council vice chairman.

Peter H. Lauer has joined Flexonics Corporation of Maywood, Ill. as controller. He has previously served as controller of the Warwick Manufacturing Company and has worked in the same capacity for the Armour Research Foundation.

Hugh H. Beach has been appointed assistant to the vice president of the Texas Company's Domestic Producing Department. He succeeds S. A. Berthiaume who was recently named vice president and manager of the Texaco Exploration Company, Calgary, Canada. Dr. Beach, formerly chief geologist of the department in Houston, will have his headquarters in New York.

Promotion of Donald A. Drake to Southwestern district manager for Tube Turns Plastics, Inc. has been announced together with the company's establishment of a full-time district sales office in the Southwest with headquarters in Houston.

Myles T. Musgrave has been named assistant to Dr. Harold J. Dawe, research director for Acheson Industries, Inc., of Port Huron, Mich.

(more on p. 72)

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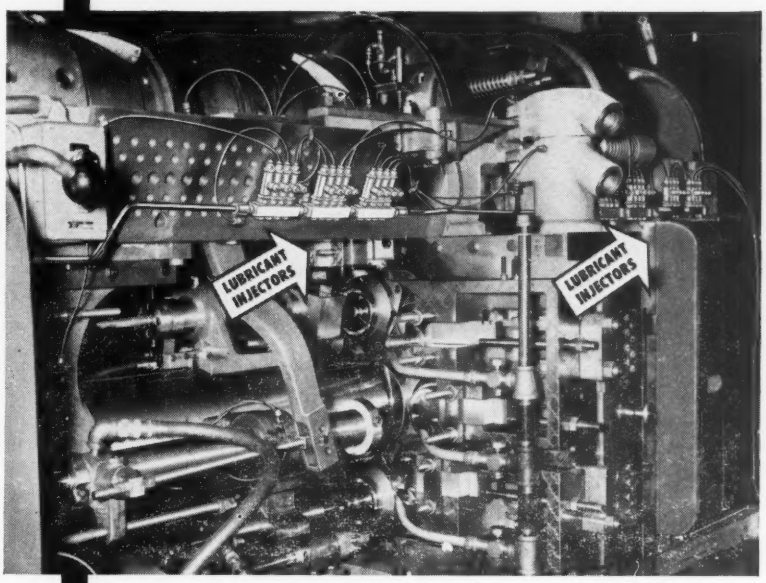

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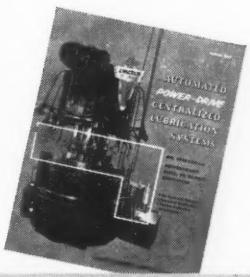

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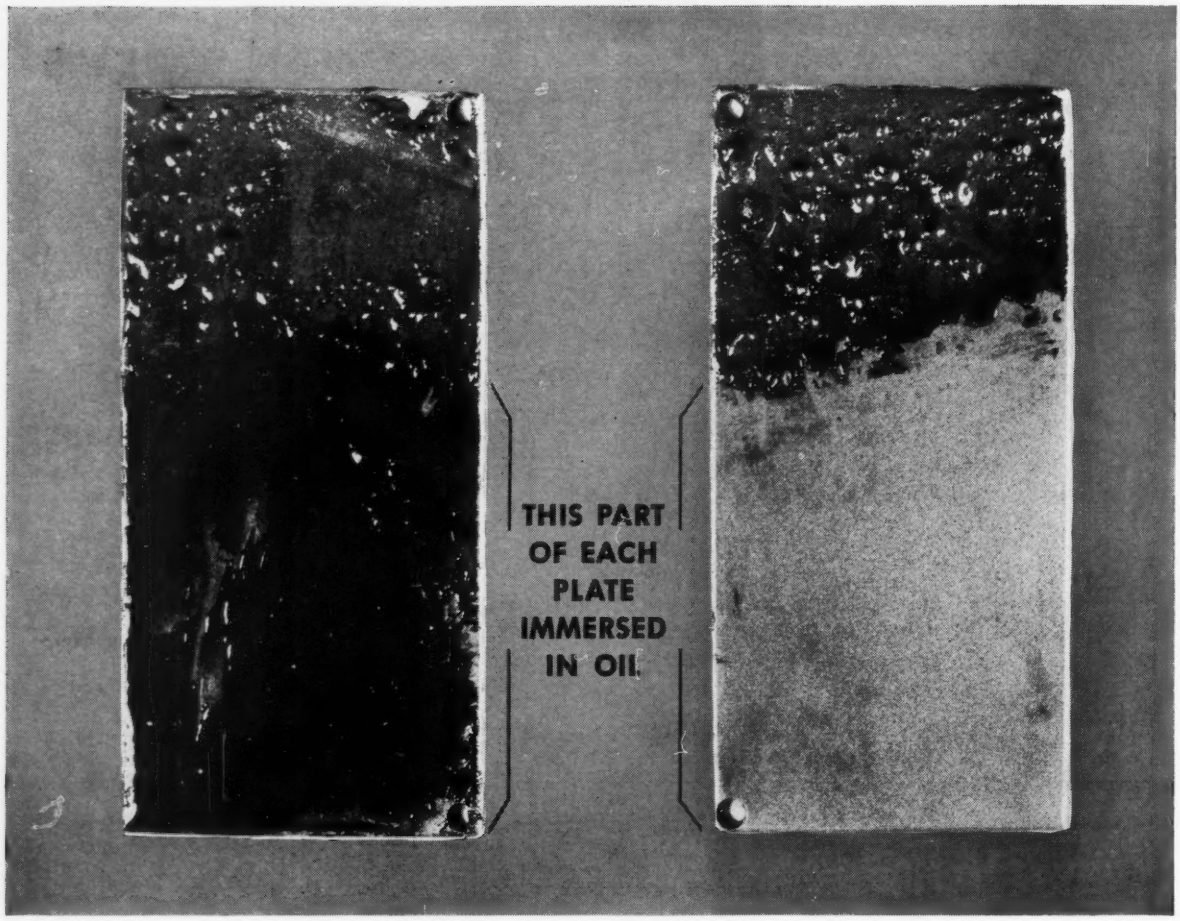

This sludge-coated metal plate was partially immersed in a beaker containing a *regular hydraulic oil* heated to normal operating temperature. Though the oil was agitated throughout the test, nearly all the sludge remained on the plate.

This similarly sludge-coated plate was partly immersed in a SUNVIS 700 oil, also heated to normal operating temperature. During the same period, with the same degree of oil agitation, the immersed part of the plate was rinsed clean of sludge.

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RESEARCH APPLICATION EDUCATION MAINTENANCE

Journal of the American Society of Lubrication Engineers *Vol. 14 No. 2 February 1958*

Foreign Technical Information Center

Engineers and scientists recently have been critical of the lack of funds applied to research in basic fields. Much of this philosophy has been dominated by economic considerations. Industry, and the government spent money only where such expenditure led to additional sales volume or engineering advantage over competition. Many have said that this course resulted in our "coming in second" in the race for outer space.

ASLE has long acknowledged that the proper function of a professional engineering society is to increase the fund of scientific knowledge. To provide the broadest range of information about our field, the various technical committees and industry councils of the Society have organized abstracting groups to search and document the existing literature. In recent years, we have also published many reports of new literature available from the Commerce Department's Office of Technical Services in Washington, D. C.

Late last month Commerce Secretary Weeks announced additional steps being taken to supply information to increase our scientific knowledge through the establishment of a Foreign Technical Information Center within the Department of Commerce. To support the new center, $300,000 was requested as a special appropriation to initiate the project, and the President's budget for 1959 includes $1,250,000 for the foreign technical information program.

The function of the new center will be to collect, evaluate, and distribute valuable foreign scientific and technical literature for the use of American scientists and engineers. No central government agency exists for channeling information of this type to the various research institutions, scientific bodies, and our scientists.

Public distribution of information from the National Science Foundation, the Atomic Energy Commission, the armed forces, and the intelligence agencies in the form of abstracts and translations of foreign technical articles, monographs, and books will be supplied at an estimated rate of 50,000 abstracts and 10,000 complete translations annually. The items will be catalogued in the library of the Office of Technical Services and abstracts will be published and released through the technical press. To assist in the selection of the foreign publications reviewed and analysed by a staff of engineer-translators, a scientific advisory committee will be appointed. Among the material to be reviewed are copies of 200 important Russian scientific journals.

The new center will operate a coordination service to eliminate duplication of translating among U. S. public and private agencies and by friendly foreign governments. In its own translation work, the center will concentrate on technology. Cooperation from industry, universities, libraries, and commercial translation firms will be sought in feeding information to the center. Studies will continue on additional ways to improve the collection and dissemination of foreign and national technical information.

ASLE will continue to work through its committees and councils to supply the readers of our journal with the most comprehensive digest of the progress in our field of science. The additional abstracts help in the fields of foreign literature being supplied by OTS will be used for the journal as long as it serves our readers.

J. O. McLean, President

Fog Lubrication of Machine Tools

D. G. Faust, Vice President, Marketing,
C. A. Norgren Co., Englewood, Colo.

In 1952, the writer had the privilege of presenting before the 7th annual meeting of the American Society of Lubrication Engineers a paper entitled, "*Oil Fog Lubrication.*" This paper dealt with some of the fundamental theory underlying the behavior of lubricating aerosols. The research preceding and subsequent to the aforementioned paper established the criteria which made possible the development of aerosol lubricators of greater oil output capacity and the application techniques so necessary to the successful utilization of this type of lubrication on a wide-spread, practical industrial basis.

During recent years, centralized air-borne lubrication systems have been applied to a wide variety of types and sizes of machines used throughout industry. Prior to 1950 it was the general consensus that aerosol lubrication was limited to and effective only when applied to small, high-speed precision bearings. Today, the size of the bearing or bearing surface presents no obstacle. The fundamental theory underlying the lubrication of large bearings or bearing surfaces is identical to that for small bearings. The basic difference is the fact that the large bearing requires more lubricant.

It should be clearly understood that oil-fog lubrication is not suggested as a "cure-all" for all lubrication problems. This relatively new lubrication concept definitely has its place in industry. It has been industry-proven to offer lubricating advantages heretofore not available.

The oil-fog lubrication technique utilizes compressed air to break up a lubricating oil into finely divided oil fog or lubricating aerosol. The individual oil-fog particles are approximately 2 microns in diameter. For all practical purposes, these small oil-fog particles can be considered truly air-borne. They can be conveyed through complex piping systems over distances of several hundred feet if necessary, and proportionately distributed to a multiplicity of outlets, the quantity or rate of oil-fog discharge at each outlet being predetermined and established by the distribution system design. Therefore, a centrally located aerosol lubricator can provide appropriate lubrication to all machine components; bearings, gears, chains, slides, ways, etc., at a nearby or remote point, irrespective of the size of these components.

An understanding of some of the fundamental principles governing the behavior of lubricating aerosols will undoubtedly assist in an understanding of the application techniques employed. Figure 1 illustrates the relationship between effective velocity of impingement and aerosol particle size on the wetting characteristics of lubricating aerosols. As the particle size becomes smaller, the velocity of impingement must become greater in order to produce effective wetting; and conversely, the larger oil-fog particles will effectively wet at lower velocities of impingement. The lubricating aerosol should have an individual particle size of approximately 2 microns. This can be transmitted through a piping system without significant reclassification or condensation if the velocity of transmission is kept low enough so that the impingement velocities of the individual oil-fog particles remain in the area marked "Dry region" below the lower curve on the graph, Figure 1.

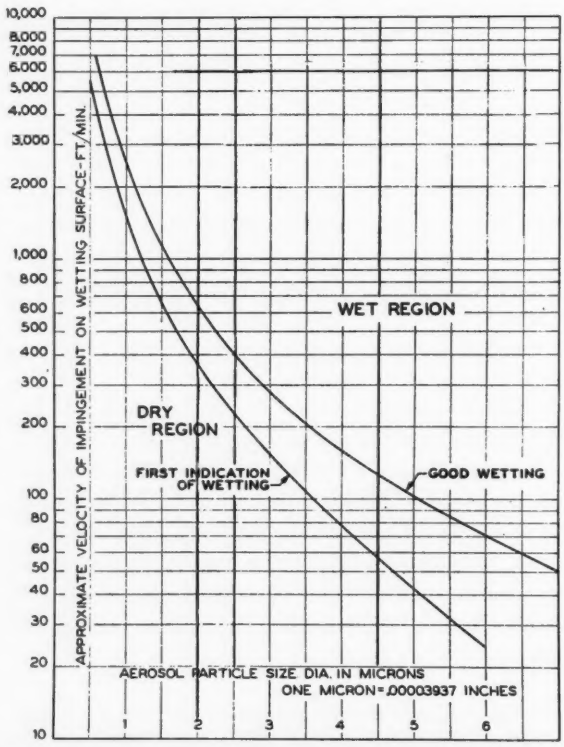

Figure 1. Effect of velocity of impingement and aerosol particle size on wetting characteristics of lubricating aerosols.

For this 2 micron lubricating aerosol to wet out on a bearing surface and provide effective lubrication, it is necessary for the velocity of impingement to be considerably greater, usually beyond the realm of practicality. Therefore, at each point of lubricant application, a reclassifier fitting is required to apply the finely divided aerosol particles to the bearing or onto the bearing surface requiring lubrication.

The reclassifier serves basically two purposes: (1) As the finely divided aerosol passes through the reclassifier, the individual oil particle size is increased so that the aerosol emerging from the reclassifier is of a larger particle size than that entering. The larger oil particles will more effectively wet or lubricate the bearing surface at lower impingement velocities within the realm of practicality. (2) By forcing the oil to wet out on the bearing surface, it does not escape to the atmosphere, and consequently, the problem of atmospheric contamination is avoided. To achieve effective lubrication, the relationship between oil-fog particle size and velocity of impingement must lie above the upper curve of the graph, Figure 1, in the "Wet region".

Air-borne oil-fog lubrication utilizes industrially available compressed air to create and convey the lubricating aerosol. It is important that this compressed air be free of contaminants, such as pipe scale, pipe dope, condensate, etc., which are normally prevalent in all industrial compressed air lines. The compressed air should be effectively filtered immediately upstream of the lubricator. For this purpose, use a good air line filter having a filter element at least capable of removing all solid material of a particle size larger than 25 microns. Such a filter should also have provision for automatically discharging accumulated condensate and compressor oil. Experience has proven that filters requiring manual draining are not reliably serviced, and consequently, condensate will find its way through the filter and into the lubricator, contaminating the lubricant.

Aerosol lubricators are intended to operate efficiently at relatively low operating pressure and low rates of air flow. Therefore, a suitable pressure regulator should be installed immediately downstream of the filter, and upstream of the lubricator. The pressure regulator permits adjustment of the operating pressure to that which is most desirable and efficient for the particular model of aerosol lubricator being employed.

Figure 2 illustrates a typical aerosol lubricating control unit, consisting of an automatic-drain filter, a pressure regulator, and a 1-quart capacity aerosol lubricator.

Many oil-fog installations, particularly those on large complex machines, are equipped with auxiliary devices in addition to the air line filter, pressure regulator, and aerosol lubricator, to assist in properly operating and maintaining the lubrication system and providing some added degree of assurance against lubrication failure.

1. A *solenoid valve* in the air line, upstream of the lubricator, permits the lubrication system to be turned on or off as the machine is started or stopped. To serve this purpose, the solenoid is normally connected to the machine controller.
2. A *pressure switch* installed in the air line, upstream of the lubricator, can be connected to an alarm system or connected to stop the machine in the event of failure of the compressed air system.
3. A *liquid level control* can be provided for the lubricator. This control can be electrically connected to sound an alarm or stop the machine, should the oil supply within the lubricator drop to a sufficiently low level to require replenishing of the oil supply.
4. A *thermostatically-controlled heater* can be attached to the lubricator to maintain a uniform lubricant temperature, even though the ambient temperature may drop considerably.

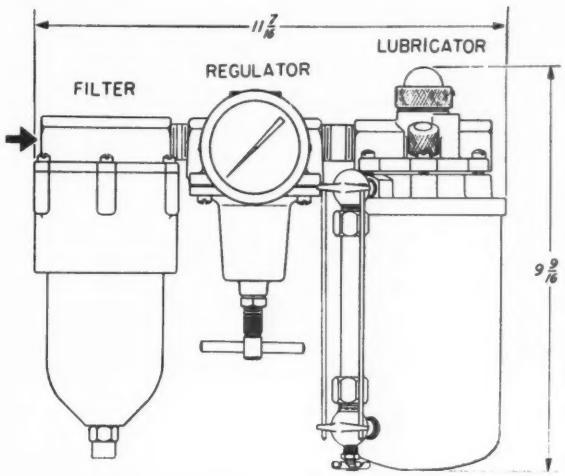

Figure 2. Typical fog lubricating control unit.

Oil-fog lubricating devices are available in a large variety of sizes and types. They can be furnished with only the essential elements of air line filter, pressure regulator, and aerosol lubricator, or with any combination of the accessory features just mentioned. Some models combine all of the features in a compact, integral unit.

A variety of sizes and capacities of aerosol lubricators are available to satisfy today's requirements. The bearing inch ratings of these units range from 32 to 1000 bearing inches in convenient increments. The oil reservoir capacities are 1/3 and 1/2 pint, 1 and 2 quart, 1-3/4, 2, and 4-1/2 gallon. It is therefore, possible to select an aerosol lubricator of suitable output and reservoir capacity to satisfy the requirements of any application.

There are practical limitations to the size of the piping used to convey the finely divided aerosol particles. It is desirable to keep the internal cross-sectional area of the pipe as small as possible and thus effect ease of installation. However, if large quantities of lubricating aerosol are to be conveyed through a piping system, the pipe must have sufficient cross-sectional area to permit transmission at a suitably low velocity to avoid reclassification within the piping system.

After studying all the effective variables, it was concluded that the internal cross-sectional area of the conveying piping should be at least six times the aggregate area of the outlets in the reclassifiers connected thereto. By following this rule, it is possible to transmit through a complex piping system a lubricating aerosol

Figure 3. Machine tool.

having a particle size of approximately 2 microns without significant reclassification of the aerosol.

In order to make possible the application of this lubricating technique to a complex machine incorporating a wide variety of sizes and types of bearings and bearing surfaces, it is necessary to have a common yardstick by which to evaluate the lubrication requirements of each of the elements to be lubricated; hence, the coining of the term, "*bearing inch.*"

In its simplest form, a single row, rolling-contact bearing on a 1 inch diameter shaft represents one bearing inch. The method of calculating the "bearing-inch" requirement for the common machine components is set forth in the following tabulation.

A. ROLLING-CONTACT BEARINGS
(ball, roller, needle)

A_1. For a single-row bearing, the shaft diameter (inches) to which the bearing is fitted equals the bearing inch rating.

A_2. For multiple-row bearings, multiply the shaft diameter (inches) by the number of rows of balls or rollers. This equals the bearing inch rating.

B. PLAIN BEARINGS

B_1. Determine the shaft diameter (inches) and bearing length (inches).

B_2. Multiply the shaft diameter by the bearing length to determine projected area of bearing surface (square inches).

B_3. Divide the projected area (B_2) by 4. This is the bearing inch rating.

C. SLIDES AND/OR WAYS

C_1. Determine the contact area between moving and stationary parts (square inches).

C_2. Divide the contact area (C_1) by 20. This is the bearing inch rating.

D. GEARS

D_1. Determine the pitch diameter (inches) and face width of the gear (inches).

D_2. Multiply the pitch diameter by the face width to determine projected area (square inches).

D_3. Divide the projected area obtained (D_2) by 4. This is the bearing inch rating.

E. CHAIN DRIVES

Obtain the following information regarding the chain drive:

1. Chain pitch.
2. Chain width.
3. Pitch diameter of all sprockets.
4. Rpm of small sprockets.
5. Number of idler sprockets.
6. Distance between centerlines of drive and driver sprockets.
7. Layout sketch of chain application.

The complexity of some of the chain lubrication problems makes it impractical to reduce this problem to a simple formula. Therefore, it is suggested that the aforementioned information be accumulated and submitted to lubrication equipment suppliers for analysis and determination of the lubrication requirements.

It is only natural that you should ask, "Why should I use this type of lubrication?" The more significant advantages of aerosol lubrication are:

1. A *centralized lubrication system* is feasible. Only one lubricator to maintain and refill.
2. *Conservation of lubricant.* Carefully metered quantities of oil are applied to each bearing. Amazing as it may seem, a few fluid ounces of oil per day have provided more thorough lubrication than previously obtained using several gallons of oil per day.
3. *More effective lubrication.* Clean oil is being applied continuously to all lubrication points in carefully metered amounts.
4. *Bearings run cooler.* Air passing through the bearing carries away heat, and there is no pool of lubricant in the bearing to generate heat as the result of fluid friction.

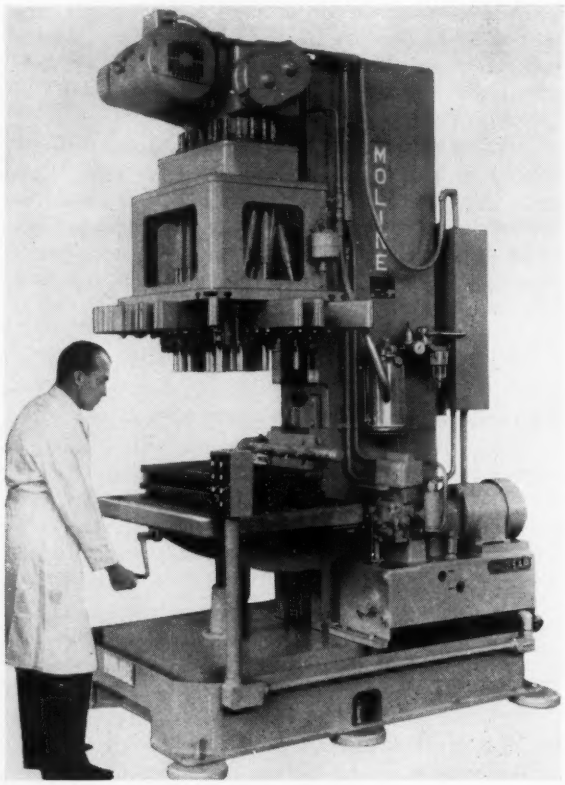

Figure 4. Multiple spindle drill press.

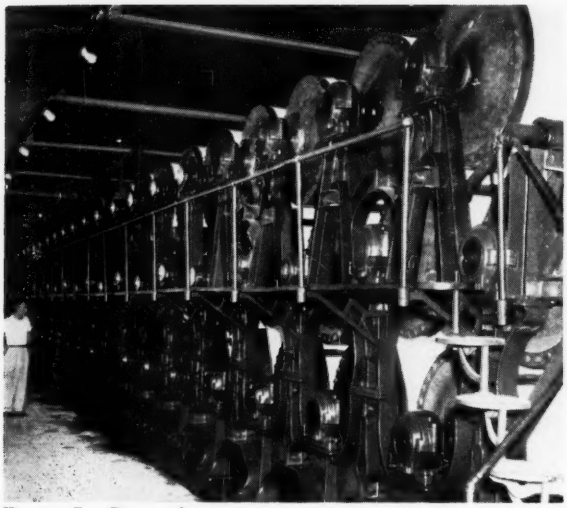

Figure 5. Paper dryer.

5. *Contaminants are excluded from the bearing.* A slight positive pressure is maintained within the bearing, and air continuously escapes from the bearing, thus preventing the entrance of contaminants from the surrounding atmosphere.
6. *Bearing seal problems are simplified.* In many instances seals can be completely eliminated. In any event, it is not necessary to maintain tight seals. The positive pressure within the bearing prevents entrance of contaminants.
7. *Less machine "downtime" and maintenance.* The continuous application of fresh lubricant results in less wear.
8. *Sumps, pumps, and filters are eliminated.* The quantity of lubricant used in an oil-fog lubrication system is so small that there is nothing to reclaim or recirculate.
9. *Cleaner work area.* There is no excess lubricant to leak out onto the floor.

Air-borne oil-fog lubrication is today successfully lubricating high-speed rolling-contact bearings fitted to a 0.090 inch diameter shaft in a dental hand-piece, on one extreme, and on the other, 4-row rolling-contact bearings fitted to 34 inch diameter shafts in a rolling mill. In between these two extremes there are thousands of successful applications on a wide variety of machines used throughout industry, including such things as transfer machines, automatic screw machines, hand screw machines, textile machinery, paper processing equipment, conveyors, high-speed grinders, etc. A few typical applications are illustrated. Figure 3 illustrates a machine tool which is 80 feet long. An aerosol lubro-control unit is lubricating 750 bearing inches in the multiple spindle heads, consisting of 350 bearings and 170 gears. The lubricant being used is a 950 second oil, Saybolt Universal Viscosity at 100° F., and the oil consumption is approximately 1.6 fluid ounces per hour, less than 1 percent of the oil consumption experienced with previous lubrication methods.

Figure 4 shows a 24 spindle drill press. The aerosol lubricator is lubricating the gearing and the universal joint in each spindle.

Figure 5 illustrates a paper dryer. Two aerosol lubro-control units are lubricating the bearings on 74 hot dryer rolls — 124 plain bearings 7 inch diameter by 9 inches long, and 24 roller bearings fitted to 7 inch diameter shafts.

It is not the purpose of this paper to detail the method used to design a complete aerosol lubrication system. Our purpose here has been to discuss some of the fundamental considerations underlying the proper application of oil-fog lubrication to complex machine tools.

Centralized air-borne lubrication of machine tools is a relatively new tool in the hands of lubrication engineers. Advancements in this field have been phenomenal, particularly during the past five to six years. It is now one of the established tools of the industry, and something which lubrication engineers should not overlook when endeavoring to solve their ever-pressing lubrication problems.

April's the month

To head for Cleveland for the

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Technical sessions covering all phases of the lubrication industry.
Exhibits by leading manufacturers and distributors in the field.

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The Effect of Additives

On Crankcase Oil Filterability

By R. L. Willis and E. C. Ballard, Petroleum Laboratory,
E. I. du Pont de Nemours & Company, Wilmington, Delaware

INTRODUCTION

The proper selection of the detergent used in the crankcase oil can increase the useful life of engine oil filters. This extension of filter life can be achieved by the use of detergents which slow the rate at which sludge accumulates on the filter. The advantages of decreasing the rate of sludge deposition on the filter include:

1. Extended life between filter changes.
2. Decreased chance for filter failure between scheduled inspections.
3. Increased opportunity for the filter to remove abrasive particles before they can contribute to engine wear.

A number of authors have studied filter performance in terms of filter media and pore size[1, 2, 3, 4, 5, 6]. However, their work was limited to comparisons between a base oil and a detergent oil[1, 2, 4, 5] and did not consider the effect that variation in the detergent used in the oil might have upon filter performance. The present study on the effect of detergents on crankcase filter performance was undertaken in an effort to extend knowledge in the field of detergency and to further study the differences in engine performance that are known to exist among detergents[7, 8, 9, 10, 11]. This program included the evaluation of the filter performance of detergents in laboratory engines as well as in two widely different road tests. The results of this work suggest that filters of increased efficiency, over those in current use, would still possess a satisfactory life if proper attention is paid to the oil formulations used with such filters. The use of such improved filters would be expected to decrease the rate of engine wear.

LABORATORY ENGINE FILTER TESTS

A series of closely matched 10W-30 oils were formulated with a variety of different detergents. The chemical and physical properties of these detergents are given in Table I. All of the oils had an ASTM slope of 0.600, a VI of 136 and a 210°F. viscosity of approximately 65.0 SUS. The oils were prepared from a solvent-extracted Mid-Continent base oil and contained the same concentrations of a zinc alkyl dithio-phosphate antioxidant and a methacrylate-type viscosity index improver, except where lower quantities of the latter were required because of the viscosity index improving properties of the detergent. The metal-containing detergents were used at a concentration corresponding to Supplement I performance level for single SAE viscosity graded oils, while each of the ashless detergents was used at a concentration recommended by the manufacturer.

TABLE I PROPERTIES OF DETERGENTS USED IN THE LABORATORY ENGINE TESTS

	Sulfated Residue, Wt %	Ba, Wt %	Ca, Wt %	Sulfur, Wt %	TBN, mg. KOH/g.
Phenate P-1	14.8	—	4.5	2.90	86.6
Phenate P-2	21.0	12.8	0.03	3.71	67.0
Sulfonate S-1	14.6	7.6	—	2.59	18.1
Sulfonate S-2	25.0	13.0	—	—	44.8
Commercial C-1	24.2	11.4	0.01	3.89	27.4
Ashless A-1	0.0	0.0	0.0	0.0	0.0
Ashless A-2	0.0	0.0	0.0	0.0	8.1
Ashless A-3	0.0	0.0	0.0	0.0	3.5

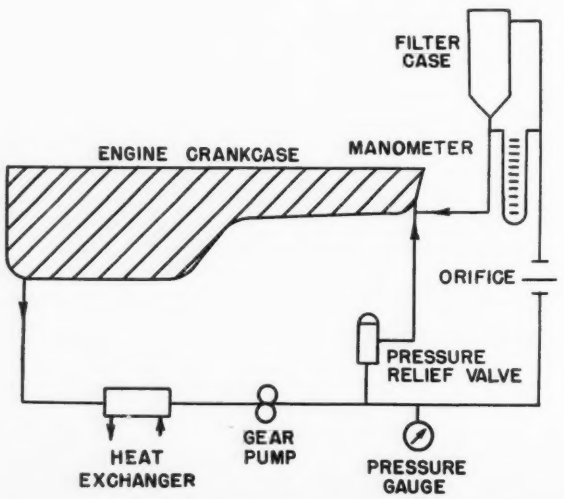

Figure 1. Filter installation on laboratory engine.

These oils were evaluated in a standard FL-2 test engine[12] which had been modified according to the CRC EX-3 technique[13]. An external oil filtration system which duplicated the flow conditions encountered in a normal bypass filter installation was used for this engine. This external oil system, shown schematically in Fig. 1, consisted of a positive displacement pump and filter assembly connected by suitable lines. A pressure relief valve in the filter bypass line controlled the pressure on the discharge side of the pump at 35 psi. The orifice which limits oil flow through a bypass filter system to approximately 0.6 gallons per minute and which is normally located within the filter case was relocated ahead of the filter case to simplify measuring the pressure drop across the filter. This pressure drop was indicated by a 30-inch mercury manometer connected to the inlet and outlet of the filter case. Standard one-quart bypass filters obtained from a single production lot were used in this program. These filters were of resin impregnated paper rated at 10 micron pore size. The engine operating conditions were those of the CRC EX-3 technique[13]. All of the tests were run in one engine which was completely overhauled after each test. At the end of the program the engine was within the wear limits established for FL-2 engines[12]. The test fuel was a blend of 90 per cent catalytic cracked stock and 10 per cent alkylate and contained 3.0 ml./gallon of tetraethyl lead as motor mix. This fuel resembled a rather clean, regular grade gasoline in FL-2 performance.

Each test in this program was run until the manometer across the filter indicated a pressure drop which just exceeded 12 psi. The pressure drop during a typical test is illustrated in Fig. 2 with data taken from a run evaluating the performance of an oil containing the sulfonate detergent S-2. The pressure drop during the major portion of the test varied with the temperature of the oil and was lowest when the engine was on the high oil temperature cycle. The pressure drop increased quite rapidly as the filter started to plug. The rapid increase in the pressure drop across the filter which occurred at the end of the test agreed with the performance of hardened paper filters in flow tests reported by S. L. Earle[14].

Data obtained in this program are given in Table II. It is evident that the life of a filter varies markedly with

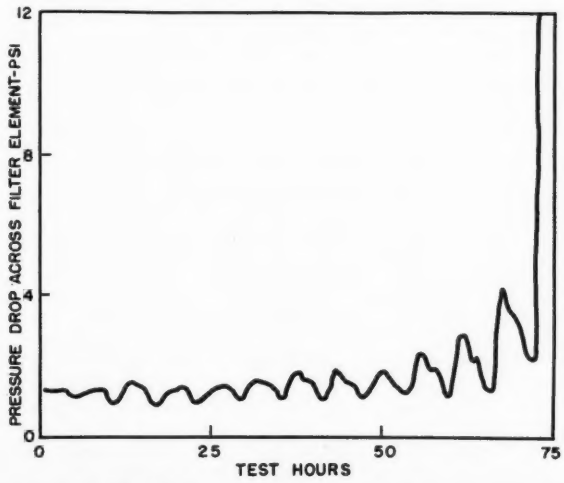

Figure 2. Typical laboratory engine oil filter test record (Sulfonate S-2).

TABLE II EFFECT OF OIL ADDITIVES ON FILTER ELEMENT LIFE IN THE LABORATORY ENGINE TEST

Detergent*		Length of Test,	Flow Thru Used Filter	Sludge on Filter,	*n*-Pentane Insol. in Used Oil,
Name	Wt. %	Hours	GPM**	Grams	Wt. %
None	None	36	3.3	93	0.10
None	None	30	—	96	0.08
Phenate P-1	3.5	36	3.3	112	0.50
Phenate P-2	4.0	55	3.5	201	0.71
Phenate P-2	4.0	48	3.3	149	0.67
Sulfonate S-1	5.0	72	3.3	181	0.67
Sulfonate S-2	3.0	72	3.9	127	1.54
Commercial C-1	3.6	126	3.5	168	2.10
Ashless A-1	5.4	150	—	151	3.71
Ashless A-1	5.4	162	3.5	109	4.10
Ashless A-2	2.5	217+	4.2	20	1.67
Ashless A-3	4.4	144	3.7	14	0.95

*The metal-containing detergents were used at Supplement I additive levels.

**The rate of flow through the new filter was 5.5 gal./min. at the 40 psig. maximum pressure of the bench test.

the type of detergent in the oil. When no detergent was present in the oil the engine ran only 30 to 36 hours before the pressure drop across the filter reached 12 psi and the test was terminated. The two phenates (P-1 and P-2) had little effect in extending filter life. Oils containing the sulfonates (S-1 and S-2) gave twice the filter life observed with the base oil. Detergent C-1 (the metal-containing detergent of unknown composition) tripled the filter life, while the ashless detergents (A-1, A-2 and A-3) increased filter life from four to six times. The amount of sludge found on the used filters varied between 100 and 200 grams except that less sludge was found on the filters using oils which contained the ashless detergents A-2 and A-3. The procedure for determining the weight of oil-wet sludge is given in the Appendix. The low weights of sludge for the tests on detergents A-2 and A-3 did not agree with data, discussed later, obtained from road evaluation of several detergents. Oil flow measurements showed that all the used filters possessed approximately 60 percent of the flow capacity of the corresponding new filters. These flow rates were determined in a laboratory apparatus described in the Appendix. This agreement in the flow rate of oil through the various filters was expected because all the filters had been run to the same pressure drop during the engine tests.

The amounts of sludge in the oils at the completion of the tests are indicated by the data on *n*-pentane insolubles presented in Table II. The amount of sludge, particularly in tests involving the base oil and the metal-containing detergents, correlated with the length of the test, with the short tests showing relatively low concentrations of sludge. The more effective the detergent in maintaining the sludge in a fine state of subdivision and in permitting the sludge particles to pass through the filter, the longer the test duration before the pressure drop to 12 psi was reached across the filter. Since the rate of sludge production was approximately constant for all tests because the fuel and engine conditions were unchanged and, since the amount of sludge removed by the filter was approximately constant for all tests, the longer

the test duration the greater the sludge content of the oil. This correlation is valid if no great difference existed among the sludge ratings of the engine after the different tests. As can be seen in Table III, the sludge ratings of these tests are approximately equal, all being in the range of 42 to 48 when 50 corresponds to a clean engine. Exceptions to the general correlation between the test length and the sludge content of the oil were encountered with detergents A-2 and A-3. The relatively low sludge content of the used oils from the tests on these detergents indicate that these materials function to minimize both the sludge content of the oil and the average particle size of the sludge. Similar observations have been reported previously[11].

The used oils were examined by means of an electron microscope to determine the size of the sludge particles retained in the oil. Most of the particles were less than one micron in diameter with an occasional particle which was two to three microns in diameter. As was indicated in the preceding discussion, the concentration of sludge particles remaining in the oil increased as the hours of engine operation increased, but the size of the particles remained substantially constant because the larger particles were continually removed by the filter. This effect is illustrated in Fig. 3 which shows electron microscope pictures of the sludge particles from oil samples taken periodically during the test on detergent A-2.

These tests showed that ashless detergents as a class extended filter life to a greater degree than other detergents. A difference was noted among the ashless detergents; A-1 acted like a metal-containing detergent and kept the sludge particles small enough to pass through the filter but did not minimize the total sludge content of the oil, while A-2 and A-3 acted by decreasing the rate of sludge formation as well as by maintaining a small particle size. Since only two sulfonates and two phenates were included in this program the superiority of the sulfonates over the phenates is not necessarily representative of a difference in the filtration performance of these two classes of detergents. However, the differences observed among the detergents used in this program do indicate that the filtration performance of detergents vary. This fact should not be neglected in the formulation and evaluation of crankcase oils.

The engine cleanliness ratings are given in Table III. Varnish ratings varied from 36 to 44 (50 equals clean) and sludge ratings from 42 to 48 (50 equals clean). Thus, the engines had similar scores although they had been run for widely different lengths of time and with oils containing a wide variety of detergents.

TABLE III DEPOSIT RATINGS OF LABORATORY ENGINE OIL FILTER LIFE TESTS

Detergent	Engine Hours	Average Piston (10 clean)	Varnish (50 clean)	Sludge (50 clean)
None	36	6.2	39	46
None	30	7.8	37	46
Phenate P-1	36	8.5	44	46
Phenate P-2	55	6.5	37	46
Phenate P-2	48	7.8	41	44
Sulfonate S-1	72	4.8	36	43
Sulfonate S-2	72	5.8	37	42
Commercial C-1	126	5.8	39	45
Ashless A-1	150	6.3	37	42
Ashless A-1	162	7.3	40	42
Ashless A-2	217+	7.7	39	43
Ashless A-3	144	8.4	41	48

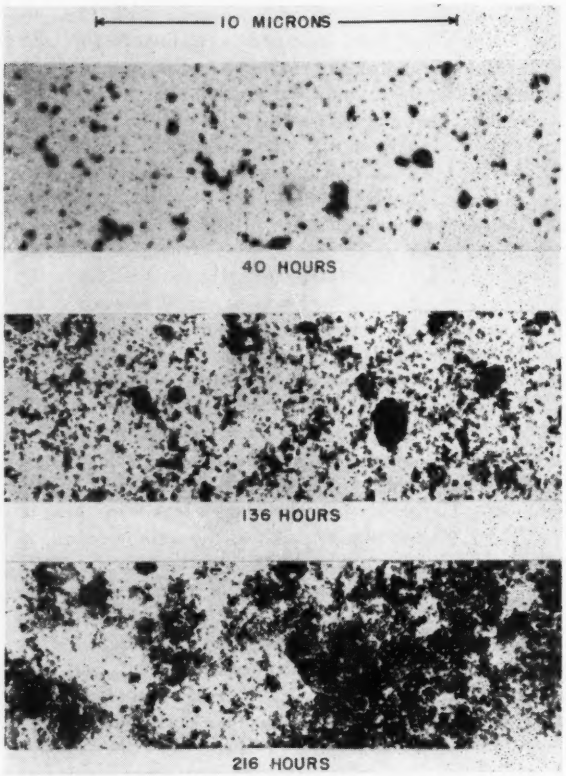

Figure 3. Growth of sludge particles during laboratory filter life test (Detergent A-2).

FILTER PERFORMANCE IN ROAD TESTS

The effect of detergents on filter life also was followed in two road tests representing the extremes of the API Classification-Service MS for crankcase oils. The condition of the used filters from these road tests was determined in the laboratory by obtaining the weight of the sludge retained by the filters and by measuring the rate of oil flow through the filters. The methods used for these determinations are presented in the Appendix.

TABLE IV ROAD TEST CONDITIONS
(API Classification Service MS)

	Road Test No. 1	Road Test No. 2
Vehicle	Tractor-Trailer Trucks	Taxicabs
Test Miles, approx.	50,000	50,000
Oil Change, miles	4,000	12,000
Filter Change, miles	8,000	4,000
Type of Operation	High Temperature	Start and Stop Low Temperature
Units on Each Oil	4	4 or 5
Filter Element	Impreg. paper or cotton waste	Impregnated paper
Filter Type	Bypass	Bypass
Filter Size	2 qt.	2 qt.

Road Test No. 1

The pertinent operating conditions of this high-temperature, heavy-duty test are presented in Table IV. The oils included one commercial oil containing a metal-based detergent and four experimental oils. The properties and compositions of these oils are presented in Table V. The experimental oil which contained detergent C-1 as the only detergent was the same blend used in the laboratory engine program previously described. All of the experimental oils were based on the same lot of solvent-extracted Mid-Continent oil and contained the same amount of a zinc alkyl dithiophosphate antioxidant. Sufficient polymethacrylate viscosity index improver was added to all but one of the experimental blends to give 10W-30 oils. This road test was not conducted primarily for filter performance data and these oils did not exactly match those used in the laboratory program.

Significant differences in the amount of sludge deposited on the filters were noted among the various oils. These differences, presented in Table VI, are average values obtained from a number of filters and were determined as detailed in the Appendix. The filters from engines operated on oils which contained detergent A-2 showed less than one-half the sludge found on filters from the oil where C-1 was the only detergent present, or from the commercial oil. The combination of detergent A-2 with detergent C-1, compared to C-1 by itself, decreased filter deposit weights by a factor of two or more, depending on the type of filter evaluated. The rates of flow obtained in the laboratory tests of the used filters correlated in general with the weights of the sludge on the filters (Table VI). The two oils which gave the greatest average amount of sludge deposition on the filters also showed the lowest rates of flow through the used filters. The phenomenon of significantly plugged filters which contained but little sludge was not observed in this road test. The average sludge content of these used oils, as indicated by *n*-pentane insolubles, was not excessive, thus indicating that the filters were still performing a useful function at the 8,000-mile drain point. If a filter had plugged completely prior to its removal at 8,000 miles the sludge content of that oil sample would have been appreciably higher than those of the other samples. The information on filter performance obtained in this road test agreed in general with that obtained in the laboratory study. Both the laboratory and road tests showed that sludge deposition in filters was dependent on the nature of the detergents added to the oils. The small increase in weight of the filters combined with the relatively high rates of flow through the used filters obtained in oils 15, 16 and 18 suggest that the filter change periods could be increased with these oils. The general correlation between the increase in weight of the filters during use and the decrease in oil flow rate through the filters, as measured in the laboratory, suggest these laboratory techniques could be usefully applied to other road test programs.

Engine cleanliness data and average wear data for the four engines on each oil are summarized in Table VII. Wear on all of these engines was not excessive. The anticorrosive wear property of the alkaline oils was not apparent because of the high engine temperatures. Engine cleanliness did vary with the oil formulation.

TABLE V PROPERTIES OF OILS USED IN ROAD TEST NO. 1

	Oil 16	Oil 12	Oil 15	Oil 18	Oil 2
Detergent					
P-1, wt %	—	—	—	3.33	*
C-1, wt %	—	3.66	3.66	—	
A-2, wt %	2.06	—	2.50	2.50	
Viscosity, SUS					
at 210°F.	56.8	64.7	64.5	64.4	58.7
at 100°F.	319	327	327	343	371
Viscosity Index	117	140	140	136	110
TAN-E, mg KOH/g	1.4	1.6	1.7	1.1	1.2
TBN-E, mg KOH/g	0.2	1.9	2.3	2.7	1.9
SAE Grade	20	10W-30	10W-30	10W-30	20W-30

*A commercially blended Supplement I level oil. All other blends contained a zinc alkyl dithiophosphate type antioxidant and greater or lesser amounts of methacrylate type VI improvers. Detergents P-1 and C-1 are at the Supplement I treating level.

TABLE VI AVERAGE FILTER ELEMENT PERFORMANCE DURING ROAD TEST NO. 1

	Oil 16	Oil 12	Oil 15	Oil 18	Oil 2
Increase in Filter Element Wt., g.					
Impreg. paper	95	681	91	141	600
Cotton waste	178	456	205	247	700
Filter Element Rate of Flow, gal./min.*					
Impreg. paper	0.92	0.16	1.09	0.59	0.43
Cotton waste	1.05	0.62	2.07	1.39	0.62
n-Pentane Insolubles in Drain Oil, Wt. %					
4000 mile point	0.41	0.25	0.55	0.50	0.26
8000 mile point	0.47	0.53	0.67	0.65	—

*Rates of flow in excess of 0.6 gpm represent relatively unhindered flow of oil through the filter when installed in the vehicle. This is because the limiting orifice in the filter case controls flow at a maximum of approximately 0.6 gpm.

Road Test No. 2

The operating conditions of this low-temperature severe-duty test are presented in Table IV. Oil changes, following the practice of the fleet, were approximately every 7,000 to 12,000 miles and filters were changed every 4,000 miles, on the average, but varied from 2,000 to 6,000 miles. These changes were made on a basis of

TABLE VII AVERAGE CLEANLINESS AND WEAR RATINGS OF ENGINES FROM ROAD TEST NO. 1*

	Oil 16	Oil 12	Oil 15	Oil 18
Varnish (50 = clean)	23	21	42	33
Sludge (50 = clean)	35	36	38	33
Oil Rings, % Plugged	34	21	48	76
Bore Wear, in 0.001"	2.3	2.6	2.1	2.5
Top Ring Gap Increase in 0.001"	58	76	63	49
Top Ring Wt. Loss, g.	1.42	2.07	1.65	1.38

*Average data from all vehicles on each oil. Data not available for Oil 2.

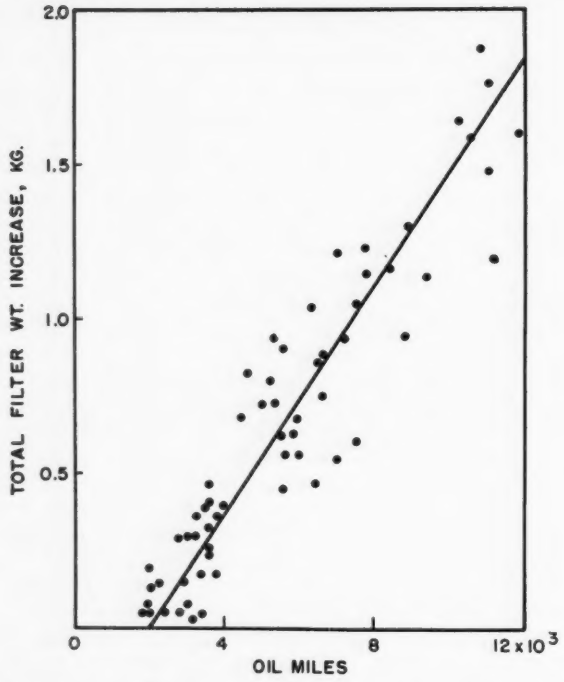

Figure 4. Filter sludge weight versus mileage for commercial 10W-30 oil.

elapsed time rather than on mileage. The long oil drain periods resulted in extensive contamination of the oils and the engines. The physical properties of oils used in this test are given in Table VIII. Fig. 4 shows the result of plotting the accumulative weight of the sludge removed from the oils by all the filters taken from all the vehicles operating on the commercial 10W-30 oil during every drain period. For example, if filters were changed during one oil drain period in one vehicle at an oil life of 2,400, 7,000 and 11,500 miles and the increase in filter weights were respectively 400, 640 and 700 grams of sludge, then 400 grams would be plotted against 2,400 miles, 1,040 grams against 7,000 miles and 1,740 grams against 11,500 miles. The average line represented by these data suggest that little, if any, sludge was removed from the oil during the first 2,000 miles of oil life. This means the detergent kept the sludge suspended for 2,000 miles, at which point the sludge began to flocculate and to be removed by the filter. Similar plots for the base oil and the commercial Supplement I oil indicate that the

TABLE VIII OILS USED IN ROAD TEST NO. 2

	Base Oil	Commercial Sup. I	Commercial 10W-30	Detergent A-2* SAE-20
Viscosity, SUS				
at 210°F.	57.5	56.6	65.9	57.5
at 100°F.	364	381	345	358
Viscosity Index	106	95	138	108
TAN-E, mg KOH/g	0.0	1.0	0.3	0.1
TBN-E, mg KOH/g	0.0	1.3	0.5	0.2

*Detergent A-2 was used at 2.5 wt. % in this oil.

filters began to remove sludge from both oils very early in the test. A plot of the data on the oil containing detergent A-2 indicates an induction period of 4,000 miles before the filters began to accumulate an appreciable amount of sludge. Oils with induction periods as high as 7,000 miles have been observed in road tests. Fig. 5 shows the average of the weights of sludge plotted against oil miles for the four oils in Road Test No. 2. The data on filter performance obtained in this road test agrees with those obtained under the very different conditions of Road Test No. 1 in indicating that the specific type of detergent in the oil had a marked effect on filter performance. Fig. 5 also illustrates that the rate of sludge removal for all the oils was approximately the same after the induction periods of the oils had been exceeded. The data indicate that the oils with induction periods did not reach a break point and rapidly deposit sludge on the filters. The filters from this road test, in addition to being weighed, were also tested in the laboratory filter flow rate apparatus. Rates of flow of the used filters varied from zero to the maximum flow permitted by the apparatus. A comparison of the weights of sludge retained by filters with rates of flow for several hundred filters showed a general correlation between the sludge content of the filter and the rate at which oil could pass through the filter, with high sludge weights generally being associated with low oil flow rates.

As can be seen by the average engine cleanliness and wear data given in Table IX, all of these vehicles were very dirty after 50,000 miles of service. The relatively low bore wear given by the commercial oil may be a reflection of the base number of the oil. The wear data were not sufficiently extensive to permit firm conclusions to be made as to the effect of alkalinity on wear.

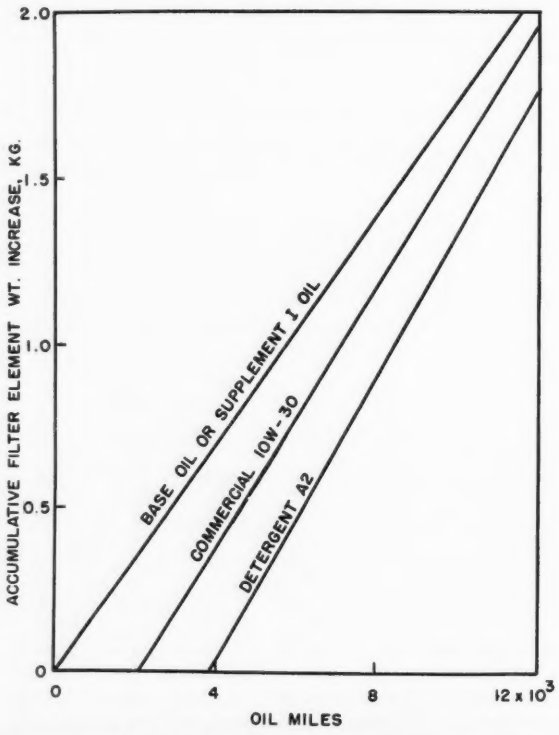

Figure 5. Sludge removal by filter elements, road test No. 2.

TABLE IX AVERAGE CLEANLINESS AND WEAR RATINGS OF ENGINES FROM ROAD TEST NO. 2*

	Base Oil	Commercial		Detergent
		Sup. I	10W-30	A-2
Varnish (50 clean)	15	14	23	23
Sludge (50 clean)	23	25	19	19
Oil Rings, % Plugging	94	71	48	60
Bore Wear in 0.001"	4.7	2.4	5.5	3.3
Top Ring Gap Increase in 0.001"	48	34	45	49
Top Ring Wt. Loss, g.	0.75	0.52	0.80	0.79

*Average data for all vehicles on each oil.

SUMMARY AND CONCLUSIONS

1. A laboratory engine test has been developed which is useful in studying the effects of oils and of oil additives on the tendency of crankcase oil filters to plug during use.

2. A sevenfold difference has been found in the ability of various detergents to minimize filter plugging in laboratory engine tests.

3. Data from two road tests operated under the two extremes of the service conditions classified by the API as Service MS suggested that under both of these conditions the specific detergent present in the oil has a marked effect on the rate at which an oil filter accumulates sludge.

4. A correlation exists between the filter performance of a detergent in the laboratory engine test and in road tests operated under the two extremes of the API Classification Service MS.

5. An ashless detergent which was best of the detergents evaluated in the laboratory engine test was also the most effective detergent in minimizing filter plugging in the field under the two extremes of the API Classification Service MS.

6. Useful data on filter performance can be obtained during road testing of oils by weighing the used filter and subtracting a suitable tare weight from the weight of the used filter.

7. A laboratory flow test to evaluate the extent of flow reduction in used filters has been developed.

APPENDIX

Determination of the Amount of Sludge Deposited on the Crankcase Oil Filter

The weight of sludge retained by a used filter was determined by weighing the filter after it had drained for at least 24 hours. The weight of the oil-wet sludge then was determined by subtracting a tare weight from the weight of the used filter. This tare weight was determined by saturating a number of new filters with fresh oil, draining and weighing. The variations in weights of drained cotton waste filters saturated with fresh oil was greater than with drained paper filters. However, the differences in weights among individual clean, oil-wet filters were significantly less than the differences in the sludge weights obtained when comparing a good and a poor detergent.

Laboratory Determination of Flow Rates Through Used Filter Elements

The extent to which deposits on the filter restricted the flow through that filter was determined in the laboratory by means of the apparatus shown in Fig. 6. A gear pump circulated oil through the system at a rate that could be varied continuously from 0 to 4.5 gallons per minute and which was measured by a totalizing meter. The filter case was modified by drilling out the orifice in the center post to eliminate that restriction of oil flow through the unit. The viscosity of the paraffinic oil used for testing purposes was adjusted so that, at 85°F., it was approximately equal to the viscosity of the SAE 10W-30 oils at 180°F. The used filters after being removed from service, were drained and weighed and then evaluated for oil flow performance in this laboratory apparatus. Specific attention was paid to making sure that all of the filter seals were tight and that the secondary orifices, normally present in bypass filter installations, were closed. The low viscosity test oil was circulated through the filter, slowly at first and the flow gradually increased until the pressure drop across the filter reached 40 psi or until the maximum flow rate (4.5 gpm) permitted by the apparatus was reached.

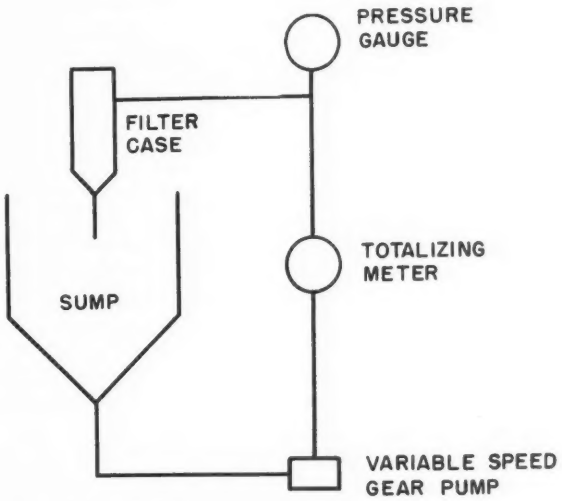

Figure 6. Filter flowrate test apparatus.

A completely plugged filter would show the limiting maximum 40 psig pressure against the filter but no flow of oil through the unit. Used filters giving a flow rate in excess of 0.6 gallons per minute in the laboratory test would be expected to give reasonable performance in service. This is because the limiting orifice in the typical by-pass filter installation limits flow through the unit at approximately 0.6 gallons per minute. Thus, in service, the filter case and the partially plugged filter would be the equivalent of two similar limiting orifices connected in series. Flow through such a pair of orifices would not be much less than through one orifice. Occasionally, a reasonable flow rate was indicated in a filter which had a high sludge weight and appeared to be badly plugged. A sufficient number of filters were tested so that, in spite of the spread of the data, the test was found to be useful.

(Cont. on p. 78)

Preparation of Highly Effective Rust Inhibitors By Fractionation of Mahogany Sulfonates

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Very effective rust inhibitors were prepared by the fractionation of commercial mahogany sulfonates. The fractionation was accomplished by continuous extraction of a solution of the sulfonate in 50 percent isopropyl alcohol with petroleum ether. Equivalent weight and rust preventive effectiveness of the fractions were determined. It was found that the rust preventive effectiveness of the fractions of highest equivalent weight was approximately three times that of the original material. Thie highest equivalent weight was 550, calculated as the sodium salt. Infrared measurements indicate that the fractions are all similar and that the structure is that of an alkylated benzene sulfonate. The similarity of the infrared curves and the equivalent weights of the fractions indicate that the differences among the fractions are in the size and possibly in the configuration of the alkyl sidechain and in the number of naphthenic rings.

During World War II, severe deficiencies in the rust protective properties of instrument lubricants were observed[1,2]. Field tests in tropical climates conducted by this laboratory conclusively established the need for improving the rust preventive properties of instrument lubricants[3]. Thus a great deal of work was stimulated during the latter years of the war and immediately following the war on the study and development of rust inhibitors. The introduction of synthetic fluids as raw materials for lubricants widened the problem in requiring that the inhibitors be effective in a variety of materials. Among the materials studied and found to be effective as rust inhibitors were the high molecular weight petroleum sulfonates, naphthenates, long chain fatty acids and amines[2,4,5,6,7]. Of particular interest were the mahogany sulfonates which because of their effectiveness, availability and relative low cost appeared desirable as lubricant additives. They are now extensively used as rust inhibitors in lubricants meeting such military specifications as MIL-L-6085, MIL-L-14107, MIL-L-17353, MIL-O-11734, etc.

A review of the various applications of the petroleum sulfonates has been published[8], and the patent literature is replete with references to the effectiveness of sulfonates as inhibitors[9].

The mahogany sulfonates are obtained on treatment of the crudes for the manufacture of white oil. The oil soluble sulfonated product, mahogany acids, are neutralized with alkali and are normally marketed in a mineral oil base, as the sodium soap. In some instances, the alkaline earth soaps are required and these are prepared by treatment of the sodium soap with a solution of an alkaline earth salt yielding the water insoluble soap, and the water soluble salt is removed by washing.

Presented before the 12th Annual Meeting of the ASLE, April 15, 1957.

TABLE I. COMPOSITION OF COMMERCIAL SULFONATES[a]

	H	P	L
Mineral Oil, %	32.1	30.9	33.6
Sulfonate, %	61.3	61.5	60.9
Carboxylate, %	1.2	1.5	1.0
Inorganic Salts, %	1.1	2.9	0.2
Water, %	4.0	4.1	4.5
Total	99.7	100.9	100.2

[a]Determined by ASTM Method D855-52T.

During the course of development of a rust preventive lubricant for mechanical time fuzes, some experiments were conducted in this laboratory on the de-oiling of commercial sulfonates by extraction with petroleum ether. It was then found that the length of time of extraction of the oil from the sulfonates influenced the rust preventive effectiveness of the finished lubricant. The longer the extraction, the lower the effectiveness of the inhibitor. It was found that a considerable amount of sulfonate is coextracted with the mineral oil. Since a nonpolar solvent was used, it was assumed that the higher molecular weight material would be the first to be removed. Upon separation of the oil from the extract it was found that the remaining sulfonate was a considerably better rust inhibitor than the original material, which meant that it could be employed in lower concentrations to give the required degree of rust inhibition. The advantages of a more effective inhibitor are at once apparent in that the use of a lower concentration to achieve the same effectiveness would result in smaller changes in the low temperature viscosity and would remove, or at least decrease, problems associated with the solubility of the inhibitor at low temperatures. A system was therefore devised to separate the mahogany sulfonates into fractions possessing uniform molecular weights.

FRACTIONATION OF COMMERCIAL SULFONATES

The commercial sulfonates used in this study were designated as *Sulfonate H, Sulfonate P,* and *Sulfonate L.* The average molecular weights of the sodium salts of these materials were 518, 516, and 421, respectively. Their compositions are given in Table I.

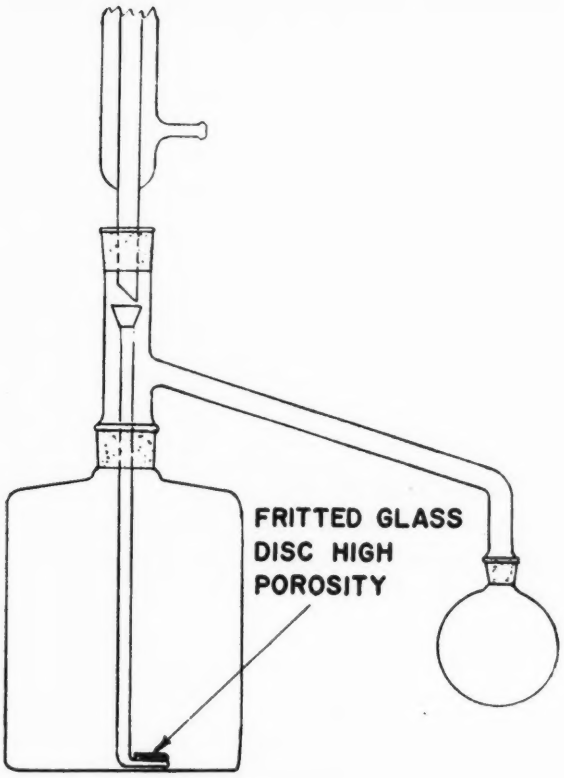

Figure 1. Extraction apparatus.

The fractionation of the commercial material was accomplished as follows: Seven hundred grams of the commercial sodium mahogany sulfonate as received were dissolved in 2800 ml of 50 percent isopropyl alcohol and placed in a 400 ml extraction bottle shown in Figure 1. The bottle was filled to the neck with CP petroleum ether (boiling range 30-65° C). The extraction apparatus was then assembled with 500 ml of petroleum ether in the boiling flask (1000 ml cap.). The petroleum ether was heated to a brisk reflux rate and the extraction continued for the desired number of hours. The extraction scheme is indicated in Figure 2. The starting material is designated as A, the extract as B-1, and the residue as B-2. Sufficient 50 percent isopropyl alcohol was added to both B-1 and B-2 to result in a concentration of approximately 25 percent of total solute, and each was again extracted with petroleum ether. The residue from B-1 was combined with the extract from B-2 and the mixture designated as C-2. The extractions were continued in this manner to the F-stage with sulfonates P and H. The fractionation of Sulfonate L was terminated at the E-stage since no sulfonate was present in fractions E-1, E-2, and E-3, and only a small amount in E-4.

A total of eight essentially oil-free fractions were thus obtained: From Sulfonate H: F-4, F-5, F-6; from Sulfonate P: F-4, F-5, F-6; and from Sulfonate L: E-4 and E-5. The compositions of the final (F) fractions of Sulfonate H are given in Table II.

Attempts to determine the molecular weights of the fractions by cryoscopic or ebullioscope methods were unsuccessful. The equivalent weights were therefore calculated from sulfated ash data. For this purpose, solutions of the samples were evaporated to dryness under vacuum on a steam bath and then dried to constant weight in a vacuum oven at 70° C before determination of the sulfated ash. It was assumed that the dry sample was 100% sodium sulfonate. Carbon and hydrogen were also determined. The results are given in Table III. The equivalent weight distribution of the sulfonate in the starting material is shown in Figure 3.

RUST TESTS

The rust preventive effectiveness of the fractions was determined by humidity cabinet tests on oil blends containing the sulfonate in the form of the barium salt. To prepare the latter, the fraction was freed of isopropyl alcohol by flash evaporation. The aqueous mixture remaining was treated with aqueous barium chloride solution in the presence of benzene. The benzene layer containing the barium sulfonate was separated and washed

TABLE II. COMPOSITION OF *F* FRACTIONS OF SULFONATE H

Fraction	Oil, g	% Starting Material	Sulfonates, g	% Starting Material
F-1	155	23.1	0	0
F-2	67	10.0	0	0
F-3	14	2.1	0	0
F-4	4[a]	0.6	35	5.2
F-5	0	0.0	66	9.8
F-6	0	0.0	335	49.8
Total	243	35.8	436	64.8

[a]This oil was removed from the extract of E-4 before the latter was added to F-4.

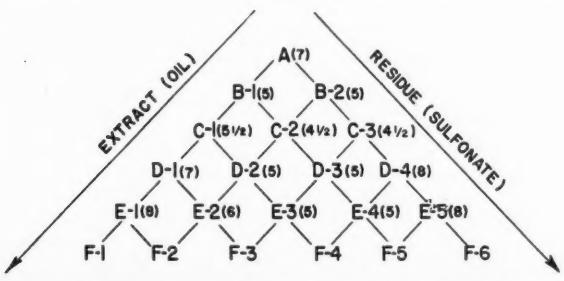

Figure 2. Extraction Scheme. (Hours of extraction are given in parentheses.)

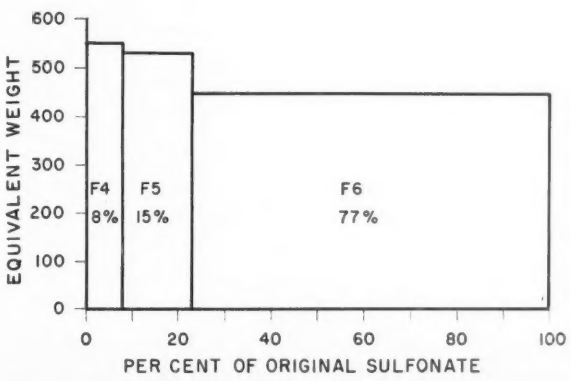

Figure 3. Equivalent weight distribution of the sodium salt of sulfonate, H.

with water to remove inorganic salts. The concentration of barium sulfonate in the benzene was determined by evaporation of a small portion to dryness and heating to constant weight in a vacuum oven. Sufficient quantities of the benzene solution were then added to bis (2-ethyl hexyl) sebacate to yield solutions containing 0.5 to 2.5 percent of the barium sulfonate after evaporation of the benzene. The benzene was then removed from the blend by distillation under nitrogen.

Rust test specimens were prepared as follows: Four inch rods of WD 1020 steel stock (⅜ inch diam.) were polished successively with 1/0, 3/0, and 5/0 sandpaper while being rotated at approximately 1700 rpm (The rods must be without pits or scratches.) They were washed in boiling benzene, followed by petroleum ether (BP 30-65°), and flashdried. They were then immersed in the test oil for 20 minutes, then placed upright in wooden specimen holders, and permitted to drain for 2 hours in a dust free atmosphere.

Rust tests were run in a cyclic humidity cabinet in which the specimens were exposed for 4 hours to 80 percent RH at 110° F followed by 4 hours at 95 percent RH at 130° F. Four test specimens were used for each blend. Observations were made at 24 hour intervals. The time of failure was taken at the first appearance of one rust spot at least one mm in diameter which grew perceptively during the next observation period, or more than one rust spot, regardless of size. The results are given in Table IV and represent the means of individual observations. (The conditions under which the humidity cabinet operates are such that they give rise to one period of controlled condensation during each cycle. The relative severity of this cabinet is considerably greater than the conventional 100 percent humidity cabinet at 120° F used for rust prevention tests. Limited comparisons have indicated an approximate severity factor of 2.5.) The values in Table IV indicate that fraction F-4 is as effective in 0.5 percent concentration as is the unfractionated sulfonate at 2.5 percent concentration. At any given concentration the ratio in rust protection between fraction F-4 and the unfractionated material is approximately 3 to 1. The increase in rust protection with increasing equivalent weight is shown in Figure 4.

INFRARED SPECTRA

Infrared spectra were determined on sulfonate H fractions F-4, F-5, and F-6 and compared with corresponding spectra of barium *para* toluene sulfonate and sodium *para* (n-dodecyl) benzene sulfonate. The curves are shown in Figure 5.

The infrared data indicate that the sulfonates are para alkyl benzene sulfonates. This confirms similar findings by Armour Research Institute[5]. The spectra failed to show any differences among the fractions. The absorption curves of barium *p*-toluene sulfonate (Figure 5A) and that of sodium *p* (n-dodecyl) benzene sulfonate (Figure 5B) are included for comparison. The common peaks and their assignments[16, 17] are listed in Table V.

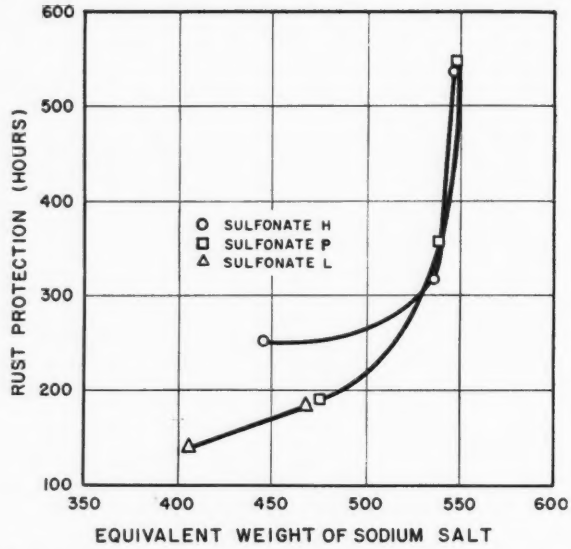

Figure 4. Rust protection vs. equivalent weight of fractions.

DISCUSSION

The sulfonates used in this study are prepared by sulfonation of mid-continent crudes. These crudes have been extensively investigated. They have all been found to contain naphthenic rings, particularly cyclopentane and cyclohexane. Ring analysis showed that the number of naphthenic and aromatic rings total from one to four. All combinations within this range have been found [10,12,13,14,15].

TABLE III. ANALYSES OF SULFONATE FRACTIONS

Sulfonate	Fract.	Equiv. Weight	%C	%H	Empirical Formulae	X in $C_nH_{2n-x}SO_3Na$
P	F-4	548	70.51	9.48	$C_{28}H_{57}SO_3Na$	13
			70.55	9.44		
H	F-4	547	70.56	9.60	$C_{28}H_{55}SO_3Na$	12
			70.50	9.64		
P	F-5	539	70.78	9.44	$C_{28}H_{53}SO_3Na$	13
			70.50	9.55		
H	F-5	534	69.43	9.03	$C_{31}H_{48}SO_3Na$	14
			69.69	8.84		
P	F-6	476	67.04	8.77	$C_{26}H_{41}SO_3Na$	11
			66.96	8.78		
L	E-4	469	67.00	8.95	$C_{26}H_{42}SO_3Na$	10
			66.71	9.01		
H	F-6	445	66.46	9.00	$C_{25}H_{46}SO_3Na$	10
			66.06	9.15		
L	E-5	407	66.61	8.79	$C_{22}H_{35}SO_3Na$	9
			66.30	8.79		

TABLE IV. HUMIDITY CABINET RUST TEST DATA

		Rust Protection (hours) at Sulfonate Concentrations of (%)			
Sulfonate	Fraction[a]	0.5	1.0	1.5	2.5
H	F-4 (547)	216	340	534	659
H	F-5 (534)	96	86	316	——
H	F-6 (445)	96	96	252	276
P	F-4 (548)	——	——	548	635
P	F-5 (539)	——	——	360	——
P	F-6 (476)	——	——	192	——
L	E-4 (469)	——	——	186	——
L	E-5 (407)	——	——	144	——
H[b]	(518)	72	144	196	235
L[b]	(421)	——	——	144	——
P[b]	(516)	——	——	224	——

[a]Equivalent weights of the sodium salts are given in parenthesis.
[b]Unfractionated sulfonate.

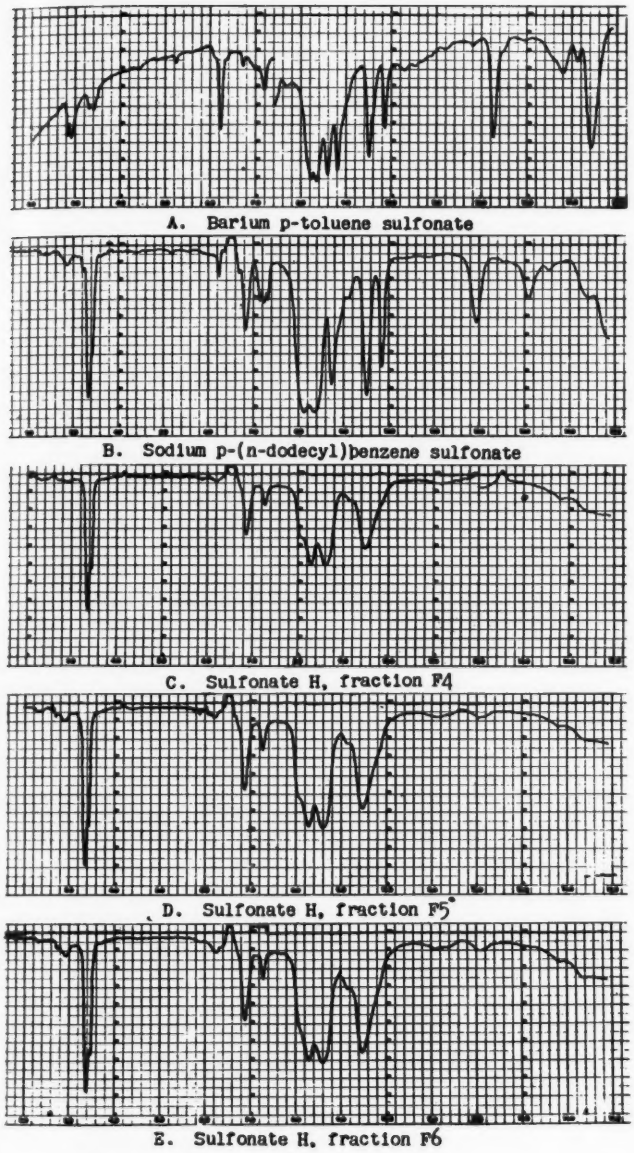
A. Barium p-toluene sulfonate
B. Sodium p-(n-dodecyl)benzene sulfonate
C. Sulfonate H, fraction F4
D. Sulfonate H, fraction F5
E. Sulfonate H, fraction F6

Figure 5. Infrared spectra of sulfonates.

Bestuchev found that a long sidechain having an average of 16 carbon atoms was another common feature[11].

Solubility of the sulfonate indicates the probability of the presence of a single sulfonate group and therefore only one aromatic ring. While the empirical formulae in Table III must not be construed as representing pure compounds, they can be accepted, nevertheless, as mean values of isomeric materials. As such, they indicate that the general formula for the low molecular weight fractions *H* F-6, *P* F-6, *L* E-4, and *L* E-5, is C_nH_{2n-10} SO_3Na, whereas that of the high molecular weight fractions *H* F-4, *P* F-4, *H* F-5, and *P* F-5 is C_nH_{2n-13} SO_3Na. This indicates that there is probably a greater proportion of rings in the higher molecular weight fractions.

Since the infrared curves of the three fractions (F-4, F-5, F-6) are identical, and since the equivalent weights of the fractions differ, it appears probable that the differences among the fractions are due to variations in the number of naphthenic rings, and in the size (and possibly in the configuration) of the side chains.

TABLE V. INFRA-RED ABSORPTION DATA

Common Peaks (microns)	Assignment
7.3, 8.3, 9.5	R SO_3H
3.35, 3.45	Alkyl sidechain (C-H stretching frequencies)
6.9	Alkyl sidechain (C-H deformation)
6.25	Benzene ring
12.0	*p*-Disubstitution

ACKNOWLEDGEMENT

The authors wish to express their appreciation to the Ordnance Corps, Army Department, for permission to publish this paper.

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Plan now for April 22, 23 and 24

ASLE Annual Meeting in Cleveland

ASLE News Notebook

Compiled by
R. D. McCormick

Joint Automotive Lubrication Conference

Final arrangements for the Section sponsored joint automotive lubrication conference have been announced by the joint committee of the Chicago Sections, SAE-ASLE. Six papers will be presented, three each in the morning and afternoon sessions to be held March 11, 1958 at the Knickerbocker Hotel, Chicago. Registration, beginning at 8:00 A.M., will include cost of the luncheon, attendance at both technical sessions, and copies of all available preprints. Registrants may also stay for the regular dinner meeting of the SAE, if they so desire. Complete program for the one-day meeting includes:

Morning Session 9:00 AM-Noon
Grand Ballroom
"Low Temperature Behavior of Motor Oils" — T. W. Selby, GM Research
"Lubrication Requirements of Outboard Motors" — W. C. Conover, Outboard Marine Corporation
"Octane Numbers from Motor Oil" — M. L. Kalinowski, Standard Oil Co. (Indiana)

Luncheon 12:15 PM

Afternoon Session 2:00-5:00 PM *Grand Ballroom*
"An Engineer's Look at Industrial Lubrication" — B. M. Dunham, Sun Oil Co.
"The Wear Problem and Techniques Involved in Determining Wear" — R. L. Pontius, Sinclair Research Laboratories
"Railroad Journal Roller Bearing Lubrication" — P. C. Paterson Timken Roller Bearing Div., General Motors Corp.

Sponsored Social Hour 6:15-6:45 PM
Dinner Meeting 6:45 PM
Grand Ballroom
Guest Speaker: Dr. D. P. Barnard, Standard Oil Co. (Indiana)

Registration fees for the conference are set at $10.00, including the dinner meeting, however, registrants may elect to omit dinner and pay the fee for the technical sessions at $5.75. Dinner reservations are being accepted at $4.25 per person and only the first 650 reservations can be accepted. Direct all reservations and program requests to:

Joint Automotive Lubrication Conference
Room 703, Fisher Building
343 S. Dearborn St., Chicago 4, Ill.

Hudson-Mohawk Plans Lubrication Course

Tentative plans for a lubrication course are being made by the Hudson-Mohawk Section. Further information will be made available in *Lubrication Engineering* as it is released.

Connecticut Section Holds Practical Lubrication Course

A series of six evening lectures on practical lubrication, designed for the plant engineer and lubrication mechanic, is being held at Trinity College, Hartford, Conn. Sponsored by the Connecticut Section, the course began on February 5, and will continue through March 19. Included in the training material are: *Basic Principles of Lubrication* (a film); *"What Lubricants Are, What They Do, and How to Use Them"* by C. H. Beckham, Esso Standard Oil Co., N. Y.; *"Anti-Friction Bearings: Ball — Roller"* by C. R. Gillette, New Departure Div. General Motors Corp., Briston, Conn.; *"Sleeve and Journal Bearings"* by K. Gooch, Farrell-Birmingham Co., Inc. Ansonia, Conn.; *"Gears and their Lubrication"* by E. S. Reynolds, Socony Mobil Oil Co., N. Y.; *"Hydraulic Systems — Circulating Systems"* by A. E. Murrow, Shell Oil Co., N. Y.; and *"Planned Lubrication in a Plant"* by E. J. Seitz, Avco Mfg. Co. Lycoming Div., Bridgeport, Conn., H. L. Smith, New Departure Div., General Motors Corp., Brystol, Conn., and H. A. Darling, American Brass Co., Torrington, Conn. The final session of the course will be combined with the regular dinner meeting of the Connecticut Section and will include an afternoon plant visit to Hamilton Standard, at Windsor Locks, Conn. until the social hour from 5:00 to 5:30 PM, dinner at 5:30. Next will be awarding of course completion certificates and a technical session entitled *"Disposal of Soluble Oil Emulsions"* by E. E. McClung, VanStraaten Chemical Co., Chicago, Ill.

Course enrollment information may be obtained from Mr. C. T. Sherer, Secretary, Education Committee, 2013 Boulevard, West Hartford, Conn. Fees for the course are set at $12.00 for members of ASLE, and $18.00 for nonmembers. Six dollars of the nonmembers fee may be applied to the 1958 ASLE dues upon application.

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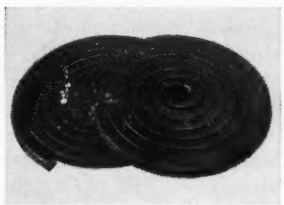

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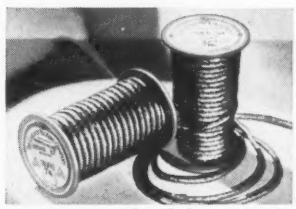

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Literature Abstracts —— W. E. Campbell, Editor

Separation of Polymers From Lubricating Oils. A Groszek (Benzole Producers Limited) *J. Inst. Petroleum, v. 43, 1957, 184-5.*

Chromatography of lubricating oils on silica gel provides an easy method for the partial isolation of oil-free, high-molecular-weight polymers. Essentially, a solution of the oil-polymer mixture in a solvent such as *n*-heptane is passed through a silica gel column. The first material to leave the column is the oil-free polymer. Experimental evidence is presented to show that the so-separated polymer is not contaminated. Results of a separation of polymethacrylate from mineral oil are given in detail. The method is claimed to work only for polymers having molecular weights higher than 10,000. *(Abstractor: E. O. Forster)*

"Effect of Lubricants upon Coefficient of Friction in the Deep Drawing of Metals." S. Ya. Veiler and G. I. Epifanov. *Doklady Akademii Nauk SSSR* 92, no. 3, 1953, 593-5.

Lubricants aid the process of drawing of a metal by decreasing the external frictional forces and by facilitating the plastic flow of metal in the surface layer. The latter effect is brought about by adsorption of surface-active substances on the developing metal surfaces in the deformation zone. The coefficient of friction f during the first draw is due mainly to plastic deformation, while f after multiple draws is due to external friction between the metal and the tool. For non-lubricated drawing, f is always highest during the first draw and decreases with multiple drawings to the following values: 0.95 for 0.1% C steel, 0.85 for brass, and 0.80 for copper. All liquids cause a marked decrease in f during the first draw. For example, nonanoic acid reduces f of steel to 1/3, of copper to 2/7 and of brass to 1/6 of their non-lubricated values. Various lubricants cause a different effect on f upon redrawing. With nonanoic acid, f of copper and brass decreases. Coefficient values change little with redrawing of steel lubricated with nonanoic acid and redrawing of copper lubricated with butyl alcohol. f increases markedly with increasing number of redraws of steel or brass lubricated with methyl or butyl alcohol. The change in the measured coefficients of friction between the first draw and multiple redraws shows that the main factor which determines the value of f during the first draw (lower than the dry value) is not the external lubricating action, but rather the plasticizing action of the lubricant. This plasticized boundary layer facilitates the surface flow of metal in the thinnest layer contacting the working tool. It is concluded that choice of lubricants for deep drawing of metals should not be based only on their ability to lower the coefficient of external friction. *(Abstraction: E. H. Loesser)*

"The Effects of Lubricants on the Surface Appearance of Aluminum After Plastic Deformation," L. H. Butler. *Metallurgia, v. 55, no. 328, 1957, 63-6.*

Compression tests are conducted on aluminum without lubricant and with lubricants not containing additives. Results show that surface appearance is dependent on condition of the tool and that, without lubricant, or with low viscosity lubricant, surface after deformation can be improved over the original appearance. Increasing the viscosity of the lubricant results in deterioration of the appearance. Work-hardened material develops microscopic cracks which are penetrated and aggravated by the lubricant. Annealed material appears to yield inhomogeneously producing duller surfaces. *(Abstractor: D. F. Miller)*

"Metallic Transfer in Engineering Operations. Radioactive Methods Used at Cambridge," F. P. Bowden and J. B. P. Williamson (Dept. of Phys. Chem., Cambridge), *Engineering, v. 182, no. 4732, 1956, 619-621.*

The amount and the influence of metal transfer between tools and products are investigated. The tools are made radioactive, and the metal transfer to the product is detected or measured by Geiger counters and autoradiographs. Results are given for the action of hammers, clamps, screwdrivers, spanners, tool bits, twist drills, and riveters on various metals. In many common machining processes the products are found to have between 10 micrograms and one milligram of foreign metal. The importance of foreign fragments in orthopedic surgery, corrosion, electric magnetic relays, and production of pure metals is discussed. Transfer can be minimized by effective lubrication or reducing the slip between surfaces. *(Abstractor: Douglas Godfrey)*

"Scoring Characteristics of Thirty-Eight Different Elemental Metals in High Speed Sliding Contact With Steel," A. E. Roach, C. L. Goodzeit, and R. P. Hunnicutt (General Motors Technical Center, Detroit, Mich.), *Trans. of the ASME, v. 78, no. 8, 1956, 1659-1674, discussion 1674-1776.*

The metals are rated according to their ability to resist scoring when pressed against a rotating disk of SAE 1045 steel, using kerosene as a lubricant. Score resistance is found to be related to the position of the metal on the periodic table. The only metals that have satisfactory score resistance against steel are those of the β subgroup which are immiscible with iron or which form intermetallic compounds with iron. The mechanism of scoring is discussed in terms of the properties of material at the intermetallic junction. *(Abstractor: Douglas Godfrey)*

"Surface Film Formation and Metallic Wear," W. Hirst and J. K. Lancaster (Research Laboratory, Associated Electrical Industries, Ltd., Aldermaston, Berkshire, England). *J. Appl. Phys., v. 27, no. 9, 1956, 1057-65.*

The change in wear rate with load is investigated using factors known to influence friction, particularly surface films, as variables. Wear is determined from conically-ended pins which are pressed against a vertically mounted, rotating stellite ring. Preliminary experiments with a variety of pin metals reveals a nonlinear change of wear rate with load, the formation of transition points in the wear-rate vs. load curves and three general types of wear. Different wear-rate vs. load curves are obtained for 60/40 brass pins using 30 percent H_2O_2, air at atmospheric pressure, air at 10^{-3} *mm* of Hg pressure, and water as medium. The results show the effect of surface oxidation. With 10 percent aluminum-copper alloy as the pins, the decomposition products in used cetane reduce wear and surface damage. The additives 1 percent zinc hexyl dithiophosphate, 5 percent oleic acid, and 1 percent dilauryl peroxide in cetane each exhibit a characteristic wear-rate-load curve. Sliding speed and surface finish are also investigated. Using brass or aluminum pins lubricated with cetane, the authors show that there is no change in wear rate with increasing stress, and thus no critical stress value at 1/3 the indentation hardness. The importance of surface films in lubrication is discussed. *(Abstractor: Douglas Godfrey)*

Product Literature

MOLYKOTE BULLETIN

Bulletin 114, covering the use of Type BR-2, a Molykote lubricant packaged in cartridges and applied from a grease gun, has been published by the Alpha Molykote Corporation, 65 Harvard Ave., Stamford, Conn. Molykote Type BR-2 is a lithium soap-grease heavy duty lubricant which combines calcium and sodium soap thickeners with the lubricity of molybdenum disulfide powder to insure water repellency, high temperature resistance, long storage life, and an almost indestructible lubricating film. The lubricant has an operating range of —30°F to 250°F and up to 350°F for short periods.

"SELECT-A-SPEDE" DESCRIBED

The "Select-A-Spede" adjustable speed drive is described in 12-page bulletin No. 2000 put out by the Louis Allis Company. The unit, available from 5 to 200 hp, is a variable-voltage DC drive that uses AC as its power source. Applications such as machine tools, metal processing, textile, paper making, test stands, and conveyors are discussed and illustrated in the bulletin. Also stressed are ease of installation, optional features for special applications and savings that can be effected by using this drive. Bulletin No. 2000 is available from The Louis Allis Co., 427 E. Stewart St., Milwaukee 1, Wisc.

INDUSTRIAL CLOTHING CATALOG

A new line of polyvinyl chloride-impregnated industrial clothing — garments, gloves, aprons — combining light weight, unusual flexibility and resistance to chemicals, oils and abrasion is illustrated in three bulletins published by Jomac Inc. The bulletins point out the advantages of these clothing items in providing protection for workers in such industries as chemical petroleum and drug and food processing. The clothing is reported to resist virtually all chemicals used throughout industry, including acids, alkalis, oils, solvents, fats, greases, alcohols and waxes. Copies of these bulletins are available from Jomac Inc., Philadelphia 38, Pa.

"LEVEL AND CONTROL SYSTEMS"

An illustrated booklet describing the measurement and control of level in industrial processes is now available. The purpose of the new booklet is to familiarize engineering and management personnel with the latest techniques and equipment for level measurement. The 16-page booklet covers applications of the company's capacitance-type device in quantitative measurement and control of granular solids, liquids, powders and interface. Several specific industry uses are described. Copies of "Level and Control Systems" are available from Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa.

TECHNICAL REFERENCE DESCRIBES SOLENOID-OPERATED LUBRICATOR

A new solenoid-operated lubricator developed to distribute lubricating oil from a self-contained reservoir or from reservoirs in the machine itself is described in a technical reference now offered by Bijur Lubricating Corporation. The sheet describes the type "E" which is available with a 3-terminal float switch and 6-pint reservoir and is actuated by a solenoid within a sturdy casing which requires no mechanical linkage. This automatic lubricating device can be mounted on many types of machinery. A total of 20 critical bearings can be served by a single lubricator. The technical reference describes operation and capacities of the solenoid-operated lubricator and includes two photographs and a diagram showing installation. For copies of the technical reference on the type "E" lubricator, write for "TR-57-E" to "Service," Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N. J.

PETROCHEMICALS BROCHURE

Amoco Chemicals Corporation has issued a 24-page general product brochure which describes the company's line of petrochemicals for the paint, plastics, rubber, chemical, petroleum, detergent and agricultural chemicals industries. Tables of typical properties are included. Copies available on request from Amoco Chemicals Corp., 910 S. Michigan Ave., Chicago 80, Illinois.

NEW BULLETIN PRESENTS PRESSURE INDICATOR-ANALYZER

Illustrated Bulletin EA-114 presents the versatile SLM engine indicator, a combined electronic pressure indicator and engine analyzer. Designed to measure all internal combustion engine pressures, ignition and vibration, this precision instrument is used for trouble-shooting, diagnosing, monitoring and adjusting today's high-speed, high-compression engines. Fully described and illustrated is the Swiss-made SLM quartz crystal pressure gage (pick-up) which, under pressure, generates an electric charge that is measured by an electrostatic amplifier and displayed on a standard oscilloscope. Numerous accessories and adaptors account for the broad range of functions measured by the automotive, industrial-marine and laboratory models. Requests for Bulletin EA-114 should be sent to Kistler Instrument Corp., 15 Webster St., North Tonawanda, N. Y.

LUBE EQUIPMENT CATALOG

A catalog of the complete line of Lincoln lubricant application equipment has been released. This manual is filled with dimension drawings and presents features of lubrication fittings, grease guns and centralized power lubrications systems and accessories. Request Catalog 92 from Lincoln Engineering Co., 5743 Natural Bridge Ave., St. Louis 20, Mo.

Personals

Hugh L. Hemmingway has been appointed director of research for the Pure Oil Company. Mr. Hemmingway will direct the activities of the company's research center at Crystal Lake, Ill. which will become his headquarters.

Election of Huntington Eldridge as president has been announced by the Chek-Chart Corporation. Formerly executive vice president of the firm, Mr. Eldridge succeeds the late Raymond Shaw, president and founder.

Three employees at the C. A. Norgren Company have been promoted to executive positions. Edward H. Roos, factory manager since 1949, was named vice president in charge of engineering, production and purchasing. Succeeding Roos as factory manager is Richard L. Beach, former assistant to the firm's executive vice president. James S. Machen has been appointed plant superintendent, a new position in the firm's manufacturing division.

Kenneth C. Edson has been appointed Los Angeles district sales manager by Kelite Corporation, manufacturer of industrial chemicals and steam cleaning equipment.

American Potash & Chemical Corporation has opened a Great Lakes-Midwest territorial office in Chicago to service an area bounded roughly by North Dakota to Kansas on the west, Oklahoma to Arkansas on the south, and Kentucky to Michigan on the east. John L. Anderson has been appointed manager of the Chicago office.

Cyril Ainsworth, technical director of the American Standards Association, has been appointed deputy managing director of the association. J. W. McNair, assistant technical director, will succeed Mr. Ainsworth as technical director and will also serve as the organization's assistant secretary. Vice Admiral George F. Hussey, Jr., USN (Ret) was re-elected managing director of the ASA board of directors.

Use the Advantages of the Emolein® Azelates and Pelargonates to Capture Your Share

The new passenger jet air age, depicted by the Boeing 707, will soon require substantial quantities of synthetic lubricants. By basing them on the Emolein Azelates, already proven in military applications, you get the advantages of a combination of many desirable features including 1) extreme heat and cold performance 2) uniform temperature-viscosity performance, high viscosity index, 3) low pour point, 4) excellent lubricity, 5) stability to corrosion and oxidation, 6) high flash and fire points and 7) excellent additive response.

Newer pelargonate and azelate diesters offer additional advantages in formulating to obtain special characteristics as well as lower cost with no sacrifice in performance. Although these are presently in development stages, they are available in tankcar quantities.

An equally important advantage for azelates and pelargonates is their ready availability. Both are derived from abundantly available domestic tallow and thus are not dependent on foreign raw-material sources or strategic stockpiling.

For detailed information on any of these products, mail coupon below.

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Section News

Section-touring ASLE National President John McLean (right) paused long enough in his travels to pose with Adrian West, Section chairman, at a recent Northern California Section meeting.

Los Angeles — Dinner, social hour and discussion held jointly with Society of Aircraft Materials Process Engineers. Speaker at January 8 session was Douglas Godfrey of California Research supplementing talk on fretting with a color movie. . . . **Houston** — Dr. P. A. Asseff of Lubrizol Corporation spoke on "Automative Gear Lubricants". . . . **Rochester** — Joint sponsorship by Rochester ASLE and Rochester Institute of Technology of an evening course in lubrication at Rochester Institute of Technology starting February 3, 1958. . . . **Chicago** — Doorprizes and cocktails highlighted meeting which featured practical hints on selection of cutting and grinding oils as divulged by Fred J. Smith of D. A. Stuart Oil Company. . . . **Buffalo** — General Electric's E. R. Booser spoke at special anniversary meeting which honored the 11 men who have served as Buffalo Section chairmen. . . . **Northern California** — January 9 meeting started off with plant tour of Western Die Casting Company, continued on to dinner, and ended with meeting sparked by Western's Ernest C. Ike speaking on "Lubrication Problems in the Die Casting Industry. . . . **Montreal** — "Bring-A-Guest" policy firmly adhered to by all members in November. December's speaker was Alex Scott, past section chairman, whose topic was "Lubrication and Preventive Maintenance in the Steel Industry." January's meeting was social get-together with members viewing Kitimat Story film. . . . **Syracuse** — January 20 meeting featured Sun Oil Company's Banks Van Ormer's discussion of the petroleum industry. . . . **New York** — Coast-to-Coast traveler ASLE National President J. O. McLean (see photo) appeared at President's Night. . . . . **Minneapolis** — Dyckman Hotel housed dinner meeting for members and guests. W. E. Thill of Federal-Mogul-Bower Bearings gave informative talk on engine bearings. . . . **Ontario** — 41 members and 17 guests heard R. O. Standing of Ontario's Hydro-Electric Power Commission present the problems of maintaining the commission's water-driven generating equipment.

Connecticut — Dudley Fuller spoke on "Newest Developments in Hydrostatic Lubrication." Section has set first class in lubrication course at Trinity College for Feb. 5.

BOOK REVIEW

"Ideas, Inventions and Patents", by Robert A. Buckles. Published by John Wiley & Sons, N.Y.C., 1957, 270 pp. $5.95.

This is a readable, expert account of patent matters for all fields of science and technology.

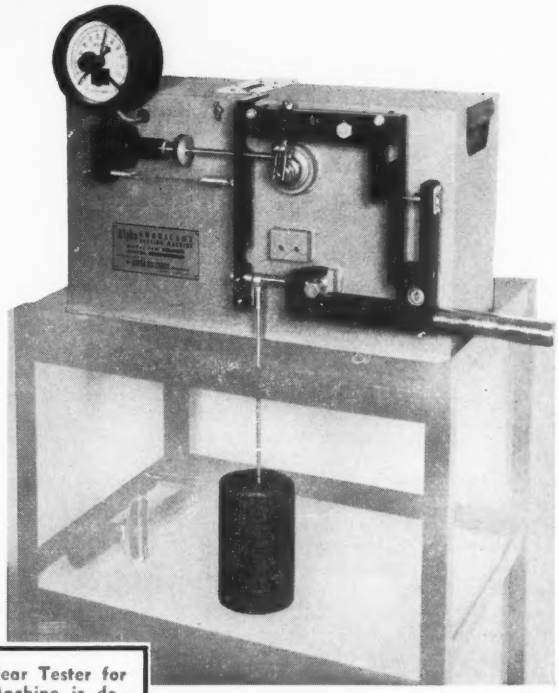
With accent on the "how to," Mr. Buckles delves into the problems encountered by inventors and technical management, giving principles and procedures that will insure genuine protection for minds at work in home or business. Each principle as it appears is accompanied by both good and bad practices, given as examples. For the guidance and instruction of new or prospective inventors who have had no previous experience with the Patent Office or with patent attorneys, the author has written an entire chapter, giving a complete case history. This begins with specific information on who may get a patent, what exactly an invention is, how to plan a patent program, how to keep records for patent protection, the role of the patent attorney, what the patent office does, and what can be done with a patent once it is issued.

The Better The Test Equipment...
THE LOWER THE COST OF PRODUCTIVE RESEARCH

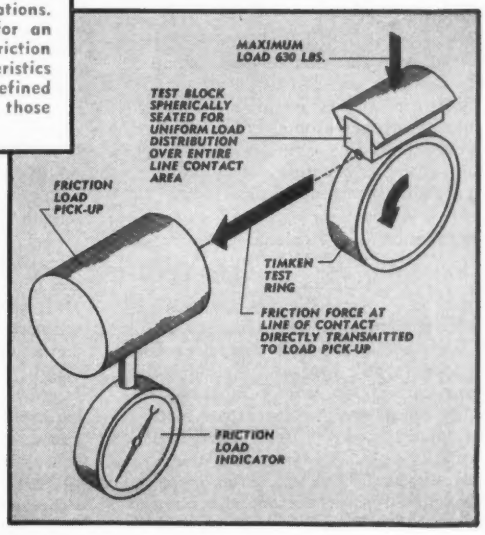
PRECISION TESTING IN THE LOW VELOCITY E. P. RANGE

Admittedly the greatest single handicap in boundary lubricant research has been the lack of tools in the form of accurate and reliable bench test equipment. The stark oversimplification of E.P. testing equipment contrasts sharply with the complexity of friction and wear phenomena. The Alpha Model LFW-1 is the result of a search for an "intermediate" between the oversimplified E.P. Bench Test and costly and time consuming full scale performance tests. Such intermediates, of which many are needed, cannot fail to sharply reduce the terrific waste of research expenditure and talent.

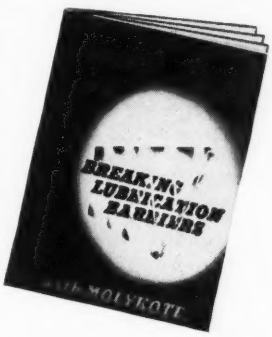
Since all E.P. lubricity ingredients function effectively only in a limited temperature range, E.P. Bench Tests must either measure frictional contact temperature or, pending the development of means to do so, simulate them. Sliding velocity is one important factor in this simulation. A large group of E.P. lubricity ingredients which are highly successful in industrial low velocity mechanisms completely fail to respond on most E.P. testers because excessive velocities and loads combine to produce frictional temperatures beyond the functional temperature range of the E.P. ingredient.



Alpha Model LFW-1 Lubricant-Friction-Wear Tester for sliding velocities below 43 feet per minute. Machine is designed for low velocity extreme bearing pressure applications. Developed by professional testing machine designers for an accuracy of better than 98% in load, velocity and friction measurements, results reflect the performance characteristics of a lubricant in a uniformly loaded and accurately defined friction area. The only variables from test to test are those intended by the operator.


MAXIMUM LOAD 630 LBS.
TEST BLOCK SPHERICALLY SEATED FOR UNIFORM LOAD DISTRIBUTION OVER ENTIRE LINE CONTACT AREA
FRICTION LOAD PICK-UP
TIMKEN TEST RING
FRICTION FORCE AT LINE OF CONTACT DIRECTLY TRANSMITTED TO LOAD PICK-UP
FRICTION LOAD INDICATOR

If you have a really important lubrication job to do involving extreme pressures or extreme temperatures, try MOLYKOTE Lubricants. Send today for complete application data and your copy of "Breaking Lubrication Barriers . . . with MOLYKOTE".



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Patent Abstracts

Compiled by
Ann Burchick, Aluminum Co. of America

Mineral Oil Lubricating Compositions, Patent No. 2,783,206 (N. V. Messina, assignor to Tide Water Associated Oil Co.) A lubricating oil composition comprising a mineral oil of lubricating grade in major amount based on the weight of the composition, a small amount of an oil-soluble half amide-aliphatic hydrocarbon ester of an aliphatic hydrocarbon dicarboxylic acid, said half amide-ester being characterized in that its amide portion contains an aliphatic hydrocarbon group as a substituent for at least one of the hydrogen atoms linked to the amide nitrogen atom, and a small amount of an oil-soluble heterocyclic carbon compound in which nitrogen is the hetero-atom, said composition being characterized by containing from about 0.02 to about 1.0% as the combined weight of said half amide-ester and heterocyclic compound in a weight ratio of said half amide-ester to heterocyclic compound to impart to said composition rust-preventive characteristics in excess of the individual effectiveness of said half amide-ester and heterocyclic compound, said half-amide ester being a compounnd in which one carboxyl group of an aliphatic dicarboxylic acid from the group consisting of succinic, glutaric, adipic and suberic acids is esterified with an aliphatic radical containing about 4 to about 20 carbon atoms and in which the amide portion of the ester contains an alkyl group of about 4 to about 20 carbon atoms substituted for at least one of the nitrogen-linked hydrogen atoms, and said heterocyclic compound being selected from the group consisting of piperidene, pyrrolidine and 1-ethyl piperidine.

Sulfonation of Petroleum Oils, Patent No. 2,783,273 (G. M. Verley, assignor to Sinclair Refining Co.) In the sulfonation of petroleum oils having a viscosity of about 100 to 300 SSU at 100 F., the method which comprises contacting the oil feed and a chlorinated hydrocarbon solvent containing not more than two carbon atoms with a sulfonating agent which consists essentially of sulfur trioxide at a temperature of about 30 to 90 F., removing the chlorinated solvent from the reaction mixture by distillation, separating oil-insoluble sludge and recovering the sulfonated oil.

Improved Trough Grease and Method of Preparing the Same, Patent No. 2,784,098 (J. B. Beverly, assignor to Standard Oil Co.) An emulsified trough grease composition which is opaque, high-melting and stable at high ambient temperatures comprising an amount of from about 1% to about 15% of a paraffin wax having a melting point in the range of from about 118 F. to about 140 F., from about 15% to about 30% of a microcrystalline wax having a melting point in the range of from about 120 F. to about 200 F., from about 60% to about 85% of a highly refined white mineral oil having a viscosity in the range of from about 55 to about 350 SSU, and from about 1% to about 15% of water, the ratio of said microcrystalline wax to said paraffin wax being at least about 2:1.

Lubricant and Method for Treating Molds, Patent No. 2,784,108 (R. A. Cupper, assignor to Union Carbide & Carbon Corp.) In the method of treatment of molds for molding glass, the steps which comprise wetting the surface of the mold at a temperature between about 250 C. and about 600 C. with a composition consisting essentially of from 1.4 to 24.7 parts by weight of glycol containing from 2 to 6, inclusive, carbon atoms and having a boiling point from about 130 C. to 250 C., from about 0.2 to 10.0 parts of the oleic acid ester of polyethylene glycol containing sufficient ethylene oxide units to give the glycol a molecular weight of about 600, from about 0.075 to 2.0 parts of dextrose, from about 0.025 to 1.0 part of a 10 percent suspension of colloidal graphite in butylene glycol and sufficient water to make 100 parts by weight, and holding the mold at a temperature at which the water volatilizes from the composition on the mold surface.

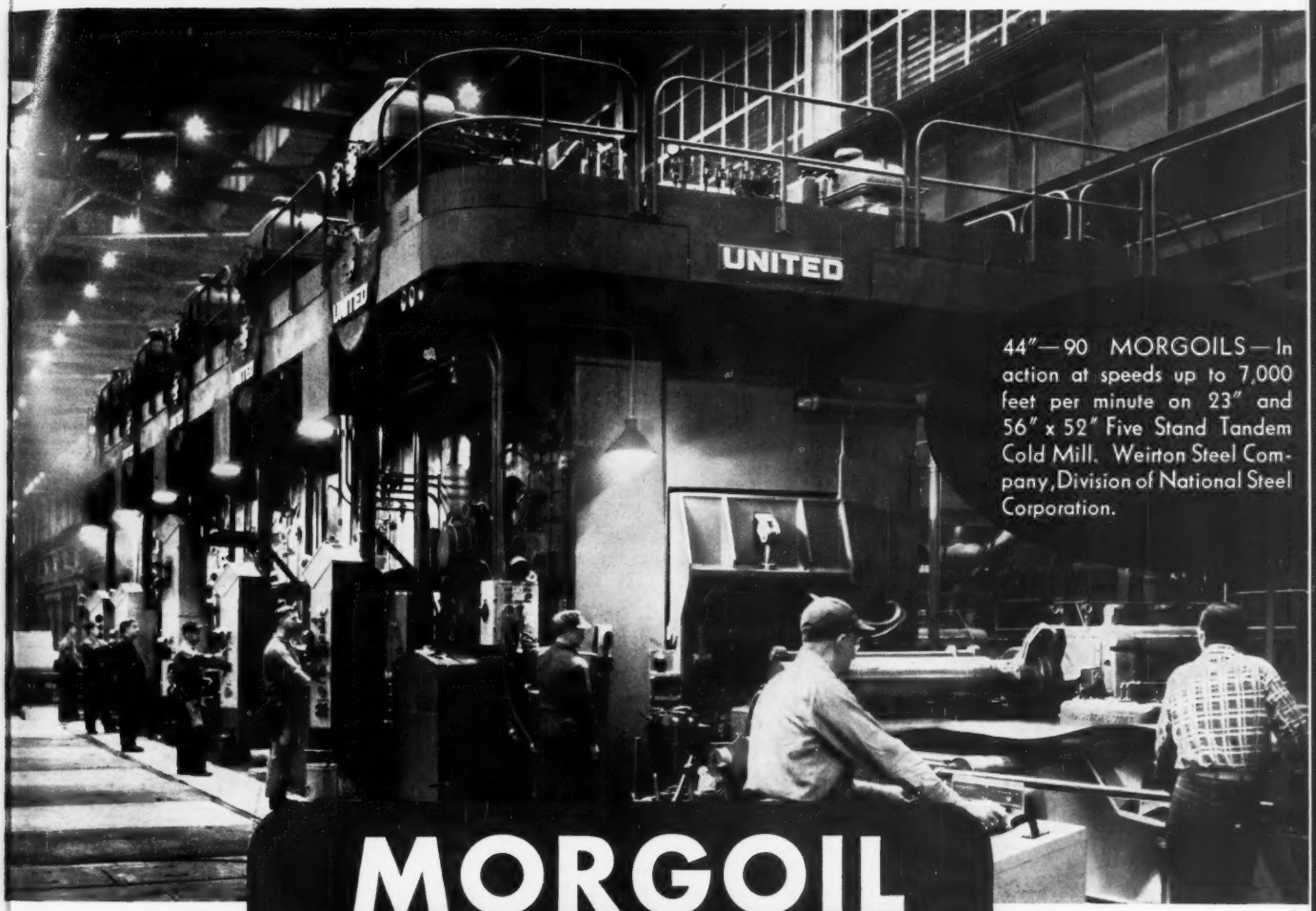
Crankcase Lubricating Oil and Additive Therefor, Patent No. 2,780,599 (J. D. Bartleson, assignor to The Standard Oil Co.) A crankcase lubricating oil containing about 0.2 to about 2% by weight of an additive comprising a mixture of silver naphthenate with a naphthenate selected from the group consisting of copper and nickel naphthenates.

Process for Recovery of Complex Ester Synthetic Lubricants from Alumina Adsorbents, Patent No. 2,780,644 (H. R. Ready, assignor to Esso Research & Engineering Co.) In a process for the reduction of the corrosivity of synthetic ester materials useful as synthetic lubricants which comprises the steps of maintaining an intimate contact with said synthetic ester material an activated particulated alumina and filtering said alumina from said treated materials, the improvement which comprises treating said filtered alumina with a paraffinic hydrocarbon solvent containing from 6 to 16 carbon atoms to selectively desorb ester material of lower corrosivity, and distilling said solvent to recover said extracted ester material.

Oil Compositions Containing Solid Particles, Patent No. 2,781,314 (J. I. Wasson, assignor to Esso Research & Engineering Co.) An oil composition of improved rust preventive properties comprising a mineral lubricating oil, 1 to 6% by weight, based on the total composition, of sodium sulfonate and 0.05 to 0.15% by weight, based on the total composition, of finely divided substantially water-and oil-insoluble aluminum hydroxide having an average particle size of about 1 to 10 microns and capable of promoting and stabilizing a water-in-oil emulsion.

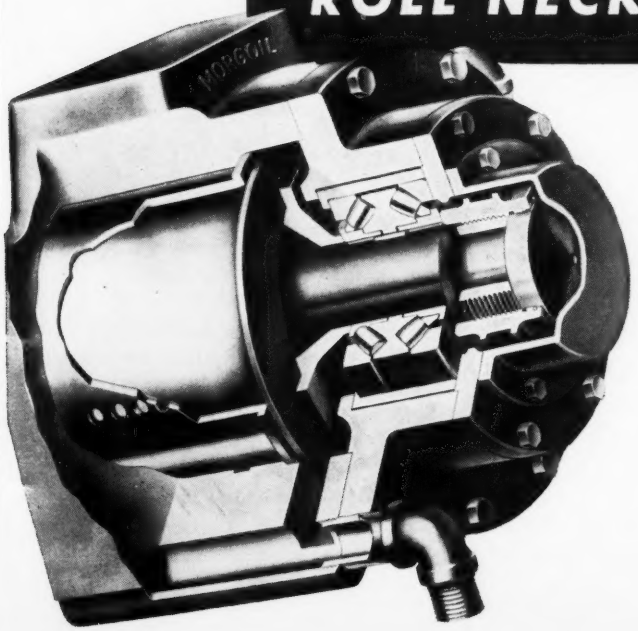
Method of Purifying, Concentrating, and Converting Petroleum Sulfonates with Ketones, Patent No. 2,781,315 (U. B. Bray, assignor to Bray Oil Co.) The process of treating a material consisting of a major proportion of hydrocarbon oil containing alkali metal mahogany sulfonates, alkali metal green acid sulfonates and water-soluble inorganic sulfate and sulfite, which comprises: forming a mixture consisting essentially of said hydrocarbon oil, said alkali metal mahogany sulfonates, said alkali metal green acid sulfonates, said water-soluble inorganic sulfate and sulfite, at least 10 parts by volume of water per 100 parts by volume of said hydrocarbon oil and sulfonates and at least 5 parts by volume per 100 parts by volume of said hydrocarbon oil and sulfonates of a hydrocarbon oil-soluble emulsion breaking liquid which is a ketone selected from the class consisting of acetone, methyl ethyl ketone, diacetone alcohol, acetyl acetone and acetonyl acetone, the amounts of said water and said emulsion breaking liquid being sufficient to produce three separate phases, a concentrated mahogany sulfonate phase containing hydrocarbon oil, water and emulsion-breaking liquid, a hydrocarbon oil phase rejected from said concentrated mahogany sulfonate phase and an aqueous phase containing alkali metal green acid sulfonates and water-soluble inorganic sulfate and sulfite; and separating said three phases from each other.

For HIGH CAPACITY at ANY SPEED



44"—90 MORGOILS—In action at speeds up to 7,000 feet per minute on 23" and 56" x 52" Five Stand Tandem Cold Mill. Weirton Steel Company, Division of National Steel Corporation.

MORGOIL
ROLL NECK BEARINGS



MORGOIL—the bearing that gives the greatest capacity and the longest life regardless of speed—gives modern high speed rolling mills top quality production with minimum down time due to bearing or roll neck failure.

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ROLLING MILLS MORGOIL BEARINGS GAS PRODUCERS
WIRE MILLS EJECTORS REGENERATIVE FURNACE CONTROL

Additive Effects on Oil Filterability

(Continued from p. 63)

False high readings of oil flow through partially or completely plugged filters are probably the result of one or more of the following conditions.

1. Leakage past the filter seals.
2. Leakage through orifices built into the filter. (These internal bypasses permit the filter assembly, in automotive service, to warm up with circulating oil and aid in establishing flow through the filter.)
3. Leaks past the filter due to faulty construction.
4. Damage to filters during handling and removal from vehicles.
5. Sections of the sludge cake disturbed or removed during draining or testing.

Proper precautions should be observed to reduce the possibility of such errors in using this procedure, particularly if only a few filters are available for evaluation.

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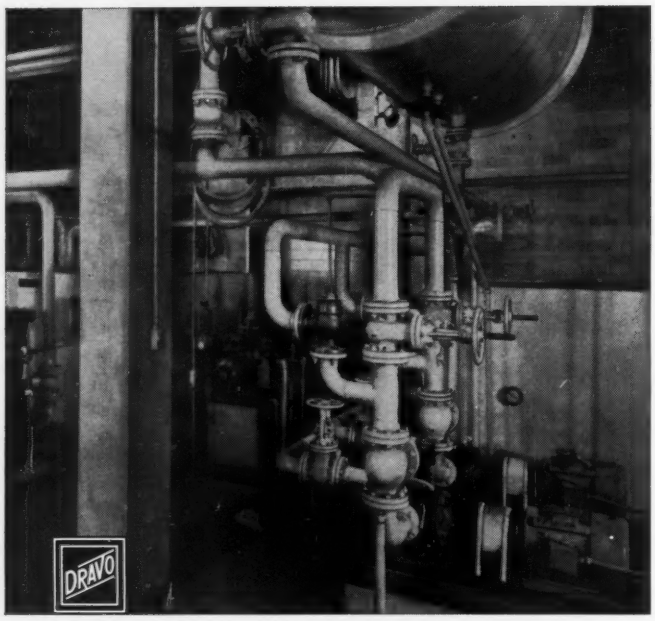
Erratum

An incorrect illustration caption for Figure 2 of the article, "A New Thickener for Multipurpose Lubricating Greases," by Rosscup, Oberlink, and Hayne was published in *Lubrication Engineering*, January, 1958. The correct caption is shown below. Our apologies to the authors and our readers.

Figure 2. Results of thin film tests.

DRAVO-DeLAVAL Lubrication Systems for Bowaters



Oil cellar for one of the lubricating systems at Bowaters Southern Paper Corporation, Calhoun, Tennessee.

Three Dravo-designed systems automatically lubricate the dryer roll sections of the huge Fourdrinier paper machines at Bowaters Southern Paper Corporation's plant at Calhoun, Tennessee. A fourth system supplies oil for fourteen pulp grinders of which six are driven by 6000 hp motors and eight by 4500 hp motors.

In service for more than three years, the lubricants have shown no change in viscosity, no oxidation, no water content and no acidity. The systems are equipped with micronic filters, centrifugal oil purifiers and include temperature and pressure controls, pumps, tanks, pressure reducing stations and control panels.

For full information on cost-saving Dravo-DeLaval Lubrication Systems, write for Bulletin No. 1450, DRAVO CORPORATION, PITTSBURGH 22, PENNSYLVANIA.

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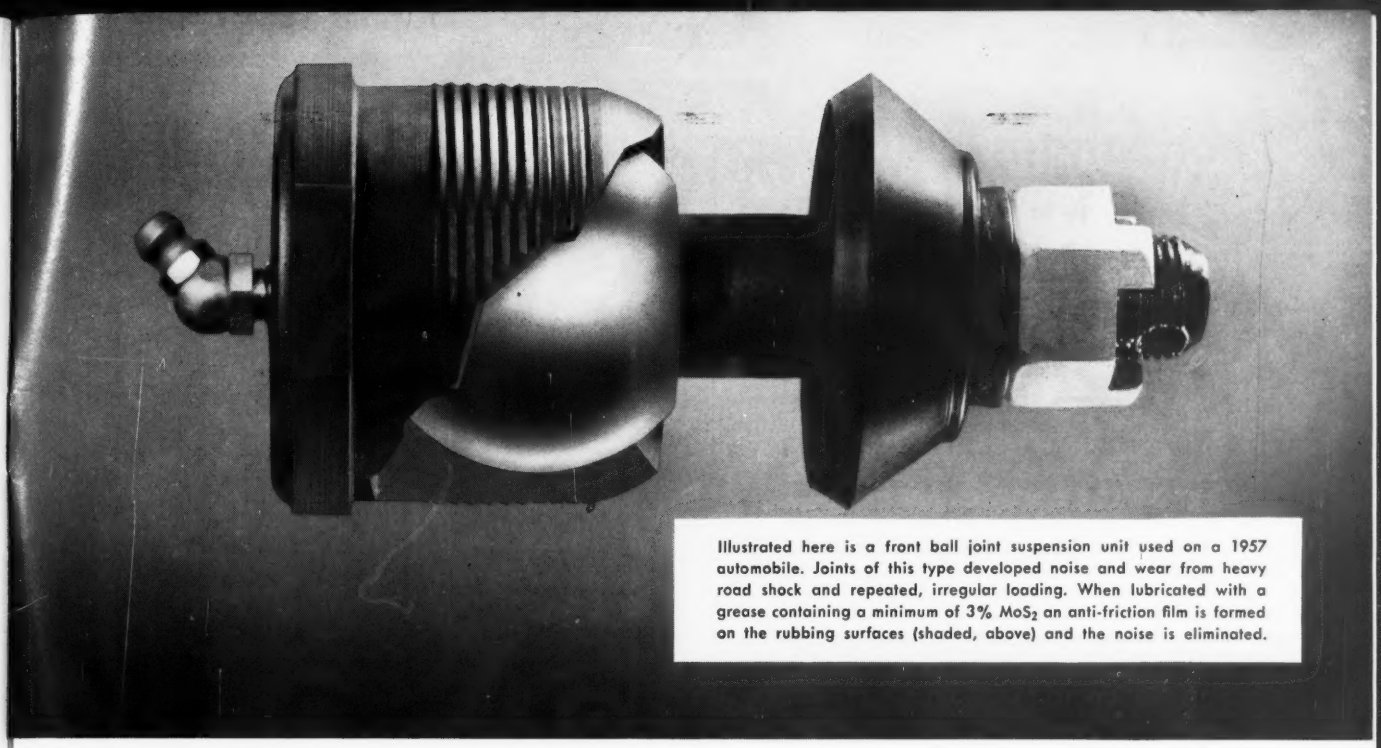

Illustrated here is a front ball joint suspension unit used on a 1957 automobile. Joints of this type developed noise and wear from heavy road shock and repeated, irregular loading. When lubricated with a grease containing a minimum of 3% MoS_2 an anti-friction film is formed on the rubbing surfaces (shaded, above) and the noise is eliminated.

When bearing surfaces are stripped of lubricants by SHOCK LOADING, OSCILLATION or RECIPROCATION . . .

MOLY-SULFIDE additive extends effective lubrication

Serious lubrication problems are often set up by extreme pressures, shock loading, oscillation and certain forms of reciprocating motion. Conventional lubricants may be forced out of the bearing area or wiped off the bearing surface. Then something more than a standard grease is required.

In situations of this kind, grease containing Moly-Sulfide proves its great value. MoS_2 is forced between the rubbing surfaces, adheres to the metal and forms a protective film that prevents galling, welding and fretting. The extent to which MoS_2 sustains lubrication is demonstrated by substantial reduction in wear, and is borne out by field reports from many different industries.

4 specific cases show advantages of MoS_2 for industry

Avoids splitting in steel punching. For example, while punching ⅝" holes in ½" thick hot rolled steel it was found that splitting of the plate frequently occurred between two adjacent holes, or toward the edge of the plate. This trouble, a result of heavy shock loading, was eliminated by brushing punches with lubricant containing MoS_2.

Makes excellent break-in lubricant for rocker arms. For break-in runs of engines, one of the major automobile manufacturers uses a supplemental MoS_2 grease on rocker arm pivots. The MoS_2 provides a low-friction film when the base lubricants wipe off under oscillating motion. This prevents galling and scoring of the mating surfaces.

Gives smooth travel to 4-ton grinding head. On a heavy cylindrical grinder the 4-ton head moves on the ways in a jumpy fashion, resulting in damage to the work. Use of a lubricant containing MoS_2 results in smooth, precise travel.

Serves well where lubricant cannot be resupplied. Moly-Sulfide is now widely used for lubricating such hard-to-reach points in automobiles as convertible top mechanisms, power operated windows and seat adjusters. Applied at assembly, the MoS_2 extends lubrication and greatly reduces noise and wear.

Many manufacturers now producing MoS_2 greases

Moly-Sulfide greases are available from many producers today. For a list of the manufacturers of these greases (Lu-2a) – which includes several major oil companies – and for a copy of "Molybdenum Disulfide as a Grease Additive" (Lu-17) write to Department 38, Climax Molybdenum Company, 500 Fifth Avenue, New York 36, N. Y.

Just a few of many ways in which GRAFO collodial dispersions can help you:

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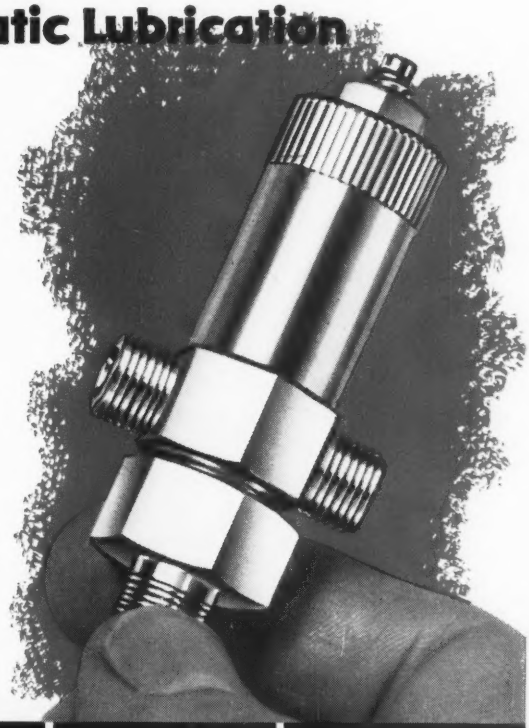
Centralized Automatic Lubrication



Alemite Type I Accumatic Valves are designed to provide an accurate quantity of lubricant to all machine bearings connected together by the lubrication system. They assure completely accurate lubrication while machine *is in operation.* Machines with multiple bearings or dangerously located bearings are lubricated from one central point in a matter of seconds . . . vital high-precision machines receive proper lubrication at all times. For fluid oils and lighter greases of N.L.G.L. No. 1 rating. Valves can be easily serviced without removing them from the system.

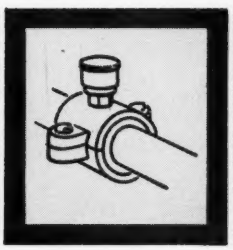
Factory-Tested—Field-Proved!

Tests show no appreciable variation in the amount of lubricant discharged after 73,312 cycles—equal to *122 years of twice-a-day service!*

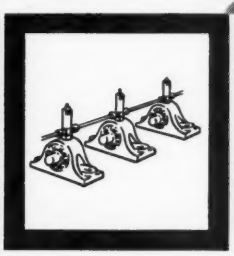
Alemite Accumatic Type I Offers All These Advantages:

- Prevents application of wrong lubricant.
- Seals completely against dirt, grit, water.
- No parts are neglected—lubricates inaccessible and dangerous bearings.
- Eliminates product spoilage due to over-lubrication.
- Eliminates point-by-point lubrication methods—services all bearings in one operation.
- Delivers exact amount of lubricant to bearing.

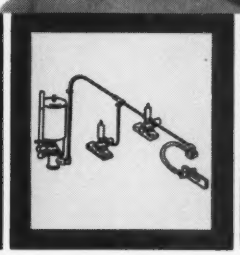
Can be designed into any machine, in 4 EASY STEPS!



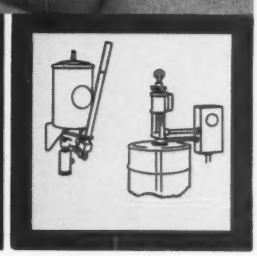
1. Remove grease cups or grease fittings.



2. Connect Accumatic fittings with copper tubing.



3. Connect sliding, rotary or oscillating parts into tubing system.



4. Provide central pump for supplying lubricant to system.

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